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Deliverable D7.1 - Regulating Electricity Storage

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Smart Island Energy Systems

Deliverable D7.1

Regulating Electricity Storage

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List of Abbreviations

ACER	Agency for the Cooperation of Energy Regulators
BESS	Battery energy storage system
CDS	Closed distribution system
CEC	Citizen energy community
CEP	Clean Energy Package
DSO	Distribution system operator
E-mobility	Electromobility
EV	Electric Vehicle
GW	Gigawatt
MWh	Megawatt hour
NRA	National regulatory authority
P2G	Power-to-Gas
P2H	Power-to-Heat
P2X	Power-to-X
PHS	Pumped hydro storage
PV	Photovoltaic
REC	Renewable energy community
SMEs	Small and Medium-sized Enterprises
TSO	Transmission system operator
WP	Work Package

***Note:** All mentions of “the 2019 Electricity Directive” or “new Electricity Directive” refer to the latest available draft of directive on common rules for the internal market in electricity voted on 26 March 2019 by the EU Parliament: [http://www.europarl.europa.eu/doceo/document/TA-8-2019-0226_EN.html].

1 Introduction

The European Union (EU) and its Member States are at the vanguard of an energy transition entailing a progressive switch from a centralised electricity system mainly based on fossil fuels to a more distributed system relying on renewable sources of electricity. However, the growing share of these mostly variable electricity sources poses new grid balancing challenges. Among the different solutions to ease the integration of variable renewable energies into the grid, storage is a prominent one. Yet, electricity storage covers many technologies, from large-scale multi-MW pumped hydro storage stations to kW-level chemical batteries, which are at different development stages. In order to foster the emergence of the most competitive and flexible storage technologies, a suitable, incentivising and harmonised legal and regulatory framework is needed both at the European and Member States levels.

Islands are perfect territories to test new energy technologies and models. By their limited size, they constitute ideal demo-sites from which the results of experiences can be extrapolated before their installation on mainland. That is where the Smart Islands Energy System (SMILE) project enters. As this report details, three islands or groups of islands located in different parts of the European Union volunteered to implement some of the energy technologies which may enable a transition to a 100%-renewable power system. From 2017 to 2021, Madeira (PT), the Orkneys (UK) and Samsø (DK) constitute testing grounds for some demand-response and electricity storage emerging technologies. In this project, electricity and heat-combined storage are tested in real-life conditions, electric vehicles charging is 'smartened' and electricity dynamic pricing is assessed. In this deliverable though, the technologies involved are limited to electricity batteries, Power-to-X (P2X) and electric vehicle (smart) charging.

The legal and regulatory framework applying to the energy sector - and the electricity sector in particular - is currently in a phase of intense change both on EU and Member States levels. The European Union has engaged in this process by issuing a set of policy goals (the 20-20-20 targets) and laws affecting market design and promoting the use of renewable energy sources (Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources). As a result, Member States have redesigned their legal framework applying to the electricity sector in order to organise the increase of electricity from renewable sources. More recently, EU institutions have been working on a set of new goals and directives included in a package called Clean Energy for All Europeans. In late 2018 and early 2019, two of the most expected components of this package have been published: namely the new Renewable energy sources directive (2018/2001) and the new Electricity Directive. These directives and other regulations provide a new legal framework concerning multiple technologies being tested on SMILE demosites, including electricity storage.

The aim of this deliverable, as a part of work package (WP) 7 dealing with legal and regulatory issues, is to analyse the current and anticipated legal and regulatory framework applicable to the electricity sector and the above-mentioned tested technologies both at EU and MS levels. This document will present an assessment of the current EU legal and regulatory framework for the electricity sector and electricity storage with special attention for islands issues before to discuss the national and local legal frameworks of Samsø - Denmark, Madeira - Portugal and the Orkneys - the United Kingdom on these topics.

2 European Union electricity market legal framework and smart islands

EU institutions adopt various type of legal or regulatory instruments, with different levels of bindingness, from treaties to opinions [1]. However, the main instruments (treaties, regulations and directives) benefit under some conditions from principles such as direct effect or primacy [2]. As a result, these texts adopted by the EU are of great importance for the Member States which must respect them. Energy is one of these fields where the EU plays a major role, although this competence is shared with the Member States [3].

In the following paragraphs, the electricity market liberalisation framework that took place in the EU and the exemptions to these rules is presented before adapting this framework to the SMILE islands.

2.1 Electricity market liberalisation and its impact on islands

Following the 1988 Working Document ‘The Internal Energy Market’ COM (88) 238, the process of energy market liberalisation is based on two main pillars: the need to apply the rules of primary EU law (the principles of free movement and competition) and the need to present secondary EU energy (and thus electricity) laws, which also are based on the basic principles of free movement and competition but apply *ex ante* (as legislation) and not *ex post* (as case law). This report will focus on secondary EU law and mainly on the directives aiming at (i) creating an internal electricity market and (ii) promoting the use of renewable energy sources.

The development of an internal electricity market started in 1996 with the adoption of Directive 96/92/EC. This directive started the liberalisation of the electricity system by providing to large consumers the right to choose a supplier [4]. The text of the Electricity Directive was amended in 2003 (Directive 2003/54/EC) and again in 2009 by Directive 2009/72/EC. The “major step forward” of the 2003 Directive is that “[a]ll consumers were given the right to choose supplier by July 2007” and not only large consumers anymore [5]. Concerning the 2009 Directive, it governs the production, transport and supply of electricity until the end of the year 2020. Very recently, a new internal electricity market was adopted, which places a strong focus on renewable energy sources and various new legal concepts, such as active customers and energy communities. In parallel, Directive 2009/28/EC promoting the use of renewable energy sources replaces an earlier directive (Directive 2001/77/EC) and has an impact on the governance of the electricity market as it provides diverging rules with regard to *inter alia* electricity production. This RES Directive was also replaced by its recast version at the end of 2018 (directive 2018/2001).

2.1.1 Principles of Market Liberalisation

The liberalisation of an electricity market is based on two main principles: (i) the need to develop a free and competitive electricity market and (ii) the recognition that this market is networkbound. These requirements will be presented in the paragraphs below.

A free and competitive electricity market for generation and supply

A free and competitive electricity market entails that all consumers should have the right to choose their supplier. In the EU this applies to consumers – household and industrial consumers – since 2007. The extent to which small consumers (households and small enterprises) make use of this right and switch supplier, differs per Member State and, inter alia, depends on the extent to which member states regulate the supply tariffs.

On the generation side, free and competitive electricity market requires a certain degree of freedom for producers and suppliers. Electricity production and supply is no longer depending on the award of exclusive rights. In principle, everyone can act as a producer or supplier if account is taken of the basic requirements presented in the Electricity directive[6].

Unbundling rules for the management of network activities

A free and liberalised electricity market depends, however, on the need of market parties to get access to the electricity grid. The electricity grid is considered a natural monopoly, as “it is not in normal circumstances feasible in economic terms to construct a new comprehensive competing network with full coverage.”[7] Given the fact that the electricity grid is a natural monopoly and in order to avoid that the owners/operators of the grid will abuse their monopoly position, the Electricity directive provides that all market parties need to have non-discriminatory access to the grid (third-party access principle) [8]. Grid owners/operators should therefore be able to act independently from production and supply. This need has led to a set of unbundling rules, starting with the requirement of a separate bookkeeping in 1996, to the requirement of legal and functional unbundling in 2003 to higher levels of unbundling in 2009, maintained in 2019 [9].

Following the need to reach a political compromise, the 2009 Electricity directive presents three unbundling options for Transmission system operators (TSOs). The first and preferred option of the Commission is the ownership unbundling (OU), clearly separating “the functions of generation or supply” from the transmission system by forcing them to split on ownership level [10]. Yet, two other unbundling options exist. Firstly, there is the Independent system operator (ISO) option [11], where the grid owner must “still be legally and functionally unbundled from the vertically integrated undertaking” but “the supplier and network can remain in the same group”. The grid is then leased to an independent network operator separated from the incumbent [12]. The second and least preferred option is to appoint an Independent transmission operator (ITO) [13]. This allows the vertically integrated undertaking to retain ownership of the network and to maintain network operation inside of the incumbent’s group but in a legally unbundled entity subject to strict independence rules [14]. In order to ensure that the chosen unbundling option creates the required level of independence, the 2009 Electricity Directive also introduces a regime of certification. When certified, the Member States still have the possibility to opt for a ‘higher’ level of unbundling (for example to switch from an ITO to an ISO or to ownership unbundling) but never to return to a lower level (i.e. from ownership unbundling to an ISO or ITO). Since 2009, “the most prevalent unbundling regime implemented is OU followed by the ITO and ISO models”[15].

The unbundling rules are less strict for the distribution sector.[16] Article 26 (1), of the Electricity Directive 2009/72/EC (art. 35 in the 2019 Electricity Directive) provides that when a Distribution system operator (DSO) “is part of a vertically integrated undertaking, it shall be independent at least in terms of its legal form, organisation and decision-making from other activities not relating to distribution. Those rules shall not create an obligation to separate the ownership of assets of the distribution system

operator from the vertically integrated undertaking.” As a result, a DSO must be independent from activities not related to distribution although it can still be owned by an energy producer or supplier, but this owner cannot interfere into the management of the distribution system assets. In other words, DSOs only need to apply the legal unbundling regime, and are not forced towards ownership unbundling.

The TSOs and DSOs are charged with a number of tasks, which all relate to their main task and that is the need to operate and maintain the grid. As a result, they need to provide customers with a connection to the grid and to give them access to the grid. Since Directive 2003/54/EC and irrespective of the type of unbundling, DSOs and TSOs need to apply a regime of regulated third party access. In this regard all Member States need to appoint an independent national regulatory authority (NRA) [17]. These NRAs are amongst other charged with setting transmission or distribution tariffs or the methodology for such tariffs or both [18]. In order to be able to carry out their tasks in an objective way, these NRAs need to be independent from government and industry [19]. Since Directive 2009/72/EC stricter rules apply to guarantee the independence of the NRAs from Government, as it was not required before [20]. The 2019 Electricity Directive only adds very limited changes to these requirements [21]. Since 2009 the NRAs also cooperate via ACER [22] in order to ensure “that market integration and the harmonisation of regulatory frameworks are achieved within the framework of the EU’s energy policy objectives” [23].

Although the TSOs and DSOs have many tasks in common, there is one task that generally is carried out by the TSO and that is the need to balance the grid, consisting in maintaining a permanent balance of the “system frequency within a predefined stability range” [24]. The unbundling of production and supply from the network activities has made the task of grid balancing more challenging. If the information provided to the TSOs is inaccurate or producers/suppliers/consumers deviate from their energy programmes there is a risk of unbalance and brown/black outs. The Electricity directives did not provide specific provisions regarding balancing. This changed in 2009 with the introduction of network codes in regulation (EC) 714/2009 of the European parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity, and more recently with Commission regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing.

Among the other tasks falling to TSOs, there is congestion management. According to Pillay, Prabhakar Karthikeyan and Kothari, “[c]ongestion takes place when the transmission lines are not sufficient to transfer the power according to market desires.” [25] This especially but not only happens at the borders between EU member states, where pre-liberalisation electricity systems limited interconnectors capacities. Congestion management therefore aims at optimising the use of the available transmission capacity where electricity supply exceeds it. With market liberalisation, TSOs are responsible for the non-discriminatory allocation of this capacity, mainly through market mechanisms [26]. On national grids, congestion episodes can happen for various reasons but a temporary strong influx of electricity produced by renewable energy sources (mainly wind and solar) is an increasing one. In this case, the TSO can proceed to a redispatch to maintain network balance. The issue then touches upon the rules of priority injection for electricity from renewable energy sources [27]. It is to be noted that with the directives adopted as parts of the CEP, priority access to the grid for electricity from renewable energy sources is now optional and in the hands of the DSO [28].

As it already appeared through some elements spread out in the paragraphs above, the European Commission issued in November 2016 a set of proposals to amend the Electricity Directive, the RES Directive and other directives and regulations [29]. These proposals are known as the CEP or Winter Package and the resulting directives and regulations were adopted between the end of 2018 and the

beginning of 2019. One of the reasons for the package is that “Europe's energy system is in the middle of a profound change. The common goal to decarbonise the energy system creates new opportunities and challenges for market participants. At the same time, technological developments allow for new forms of consumer participation and cross-border cooperation. There is a need to adapt the Union market rules to a new market reality”[30]. Although the basic principles of market liberalisation remain the same, the European legislator foresaw that the customers will become more active and new technologies will be applied, including electricity storage. Below, the exemptions to Market liberalisation are firstly discussed before assessing the implementation of market liberalisation on islands.

2.2 Exemptions to Market Liberalisation

The above rules governing the liberalisation of the electricity market and the need to regulate the grids in order to ensure all consumers non-discriminatory access to the grid against fair and transparent tariffs apply in general. However, the Electricity Directive also recognises that there may be situations where it would be better to take a different approach and to allow exemptions to liberalisation rules such as unbundling or third party access. This is, for example, the situation in case of Closed Distribution System (CDS) or when an integrated undertaking serves less than 100 000 connected customers [31]. In addition, the geography of some territories justifies these kind of exemptions, as the concepts of ‘small isolated systems’ and ‘small connected systems’ show. The exemptions discussed hereunder will allow to later assess the situation on SMILE islands.

2.2.1 Direct Lines

The notion of ‘direct line’, existing in EU energy law since the first Electricity Directive [32], is defined in the 2019 Electricity Directive, article 2, paragraph 41 as follows:

‘Direct line’ means either an electricity line linking an isolated generation site with an isolated customer or an electricity line linking a producer and an electricity supply undertaking to supply directly their own premises, subsidiaries and customers;

Its regime is further detailed in article 7 of the same directive and was only modified to a very limited extent since the 2009 directive.

Although direct lines are supposed to be electricity lines reserved for the sole purpose of providing electricity to an isolated site or a large consumer, and not used by other market actors, Gräper and Schoser argue that “given that the existence of a large number of direct lines could prejudice the effective functioning of the internal market if they were closed to third party access, a direct line should be viewed as a transmission or distribution system and thus open to third party access. [...] Where a company constructs a direct electricity line it is submitted that it will therefore have to comply with the provisions of the third electricity Directive on transmission and distribution system operators, unbundling and regulated third party access”[33]. The exemption regime for direct lines is therefore limited.

2.2.2 Closed Distribution System

In 2008, the Court of Justice of the European Union's (ECJ) issued a ruling called Citiworks, concerning the 'site network' of the airport of Leipzig/Halle, in Germany [34]. In a nutshell, the undertaking operating the airport of Leipzig/Halle obtained from its NRA the authorisation to consider the electrical grid of the airport as a 'site network' as German law authorised and could therefore restrict the access to the network for third parties. As a direct consequence, the electricity supplier Citiworks could not use the airport's electricity network anymore to supply one of its clients located in the airport. The 22 May 2008, the ECJ decided that the German provisions violated article 20 paragraph 1 of the 2003 directive, on third-party access.

Following the ruling, a new exemption to electricity market liberalisation was added in the 2009 Electricity Directive and kept in the 2019 version. Recital 66 of the 2019 Electricity Directive details what can constitute a Closed Distribution System (CDS) and what are the expected consequences of this regime:

Where a closed distribution system is used to ensure the optimal efficiency of an integrated supply that requires specific operational standards, or where a closed distribution system is maintained primarily for the use of the owner of the system, it should be possible to exempt the distribution system operator from obligations which would constitute an unnecessary administrative burden because of the particular nature of the relationship between the distribution system operator and the system users. Industrial sites, commercial sites or shared services sites such as train station buildings, airports, hospitals, large camping sites with integrated facilities, and chemical industry sites can include closed distribution systems because of the specialised nature of their operations.

According to article 38 of the 2019 directive, "a system which distributes electricity within a geographically confined industrial, commercial or shared services site and does not, [...] supply household customers", can be considered as a CDS if:

- (a) for specific technical or safety reasons, the operations or the production process of the users of that system are integrated; or
- (b) that system distributes electricity primarily to the owner or operator of the system or their related undertakings.

In article 38 (2) of the same directive, it is made clear that CDS "shall be considered to be distribution systems", meaning that the provisions applying to DSOs apply to them as well, apart for the exemptions mentioned in the same article or for those mentioned in other provisions such as with article 32 (5) concerning "integrated undertakings which serve less than 100 000 connected customers, or which serve small isolated systems". These elements were confirmed by a late 2018 ECJ ruling [35].

If an electricity system is recognised as a CDS, its operator can be exempted from "the requirement under Article 31 (5) and (7) to procure the energy it uses to cover energy losses and the non-frequency ancillary services in its system", from "the requirement under Article 6 (1) that tariffs, [...] are approved [...] prior to their entry into force" but also from some new elements of the Electricity directive. In detail, the operator of the CDS can be exempted from the obligation to procure flexibility services and "to develop [its] systems on the basis of network development plans" as DSOs usually are, and might not be concerned by the prohibition to own, develop, manage or operate recharging points for EVs and storage facilities according to the new provisions 38 (2) (d) and (e) added in 2019.

In brief, a CDS can manage a specific restricted zone and can allow to circumvent some administrative burdens for the operation of the grid. However, it cannot have for consequence to restrict the application of the third-party access principle.

2.2.3 Isolated Systems

According to article 2, paragraph 42 of the 2019 Electricity Directive, a ‘small isolated system’ (SIS) means any system with consumption of less than 3 000 GWh in the year 1996, where less than 5 % of annual consumption is obtained through interconnection with other systems. When considering this definition, two different interpretations can apply. Firstly, it can be interpreted that the 5% of imports among the annual electricity consumption only refers to the year 1996, as for the overall consumption requirement of less than 3000 GWh. In this case, then the situation remains frozen in time, and some developments like the increase of distributed renewable energy generation cannot be taken into account. Alternatively, it could be argued that the 5% of imports rule refers directly to ‘any system’, in this case opening the door for a yearly assessment of the exports/imports balance via the existing interconnection. There is no explanatory documents for this provision [36]. Nevertheless, in both cases the criterion emphasises the need to have a local network almost entirely relying on local generation, even though the isolated system can benefit from a back-up supply by another system, an element which can result vital in terms of grid balancing in the context of the integration of an increasing share of variable renewable sources of electricity in local networks, until the day storage and smart grids are fully developed. At the end of the day, SIS are qualified primarily by the amount of electricity consumed over one year (i.e. 1996). It must be specified that the directive does not provide any specific geographical requirements and thus the system may be located on an island or in a remote mountainous area as long as the system lacks a connection to the national grid and/or the supply via the main grid is limited.

Paragraph 43 of the same article refers to ‘small connected system’ (SCS). It is important to highlight that in the 2009 Electricity directive, this concept did not exist but there were ‘micro isolated systems’ instead, based on a criteria of consumption below 500 GWh in the year 1996 and without connection to other systems. With the new SCS, the consumption threshold and the year of assessment remain the same as for SIS (3000 GWh in 1996), hence are submitted to the same questions as above, but, it differentiates from SIS with the interconnection rate. A system can be considered as SCS when “more than 5 % of annual consumption is obtained through interconnection with other systems”. The tipping point to differentiate an SIS from an SCS is now based on the intensity of the use of the interconnection to other systems. From this change could be deducted that a system not interconnected to any other would directly fall under the SIS status.

If an electricity system can be labelled as an SIS, Member States are entitled to derogate to the obligation for DSOs to publish a network development plan [37] but that is not the main point. According to article 35 (4) of the Electricity Directive, Member States can derogate to unbundling rules for DSOs. Moreover, if an electricity system can be labelled as an SIS or an SCS, Member States can request a derogation to the directive’s chapters related to DSOs, TSOs, and from articles dealing with direct lines and authorisation procedures for new capacity, at the condition that the Member States can prove that it will be facing “substantial problems for the operation of [its] small connected systems and small isolated systems”[38]. The system can therefore benefit from a regime of exception avoiding major liberalised market rules. But it goes even further for SIS, which can additionally apply for a derogation to the principle of freedom of choice of suppliers for the customers, to market based supply prices and even to third-party access [39], removing it potentially completely from the liberalised market.

Among the changes brought by the 2019 Electricity Directive on this topic is article 66 (2) which states that the exemptions granted by the Commission to SIS or SCS “shall be limited in time and subject to conditions that aim to increase competition in and integration of the internal market and to ensure that the derogations do not hamper the transition towards renewable energy, increased flexibility, energy storage, electromobility and demand response.” Hence, the tailored decision which might be issued by the Commission to SIS or SCS will be more than in the past submitted to specific conditions for progressing in the energy transition and towards a liberalised internal market which might be assessed more regularly as the situation of the system changes. The same provision adds that for outermost regions (of which Madeira island is part) “that cannot be interconnected with the Union electricity markets”, the derogation is not limited in time but that it “shall be subject to conditions aimed to ensure that the derogation does not hamper the transition towards renewable energy.”

The main point to keep in mind concerning small connected or isolated systems is that it is the rate of use of the interconnection that matters. In this regard, the Regulation working group of the BRIDGE initiative¹ will issue a report in May 2019, providing recommendations for the transposition of the new Electricity Directive by the Member States, in order to give more clarity to the 5% criterion and its calculation [40].

2.2.4 Citizen Energy Community and Renewable Energy Community

Citizen Energy Communities (CEC) are a novelty of the new Electricity Directive which opens the way for a new electricity market actor. Indeed, recitals 44 to 47 already provide many elements on the nature of a CEC. In essence, a CEC is first of all a group of citizens, usually on a “local” territory, aiming at developing local (preferably renewable) energy projects and use it. Many considerations on the local distribution grid operation, the composition of the CEC or the kind of investments to be realised are touched upon in these recitals and are more detailed in the Directive’s provisions.

Precisely, article 2 paragraph 11 loosely defines a CEC as being:

A legal entity that

- (a) is based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises;
- (b) has for its primary purpose to provide environmental, economic or social community benefits to its members or shareholders or to the local areas where it operates rather than to generate financial profits; and
- (c) may engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders;

Focusing on the binding elements of this definition, a CEC has to be formed by a legal entity controlled by (preferably local) shareholders or members, involved in pretty much every existing or forthcoming aspect of the electricity system, apart maybe electricity transportation. Around these core elements, some optional aspects are mentioned to emphasise on the local and value-driven sides.

¹ <https://www.h2020-bridge.eu>

The legal regime of CECs is detailed in article 16 of the Directive. In short, Member States are responsible for creating an enabling regulatory framework for CECs, authorising them to fully take part into the electricity system without being discriminated. To detail this statement a bit, there are multiple parts in the Directive's article 16. First of all, it is clearly established that participation in a CEC is "open and voluntary", that its shareholders or members can leave it and that they shall "not lose their rights and obligations as household customers or active customers"[41]. Additionally, any "relevant" DSO has to cooperate with CECs "to facilitate electricity transfers within citizens energy communities", in exchange for a fair compensation, and CECs are subject to "non-discriminatory, fair, proportionate and transparent procedures and charges"[42]. Following these core elements of an enabling regulatory framework, the Directive proposes other provisions that Member States "may" transpose in their legislation. CECs may be open to cross-border participation, entitled to own, establish, purchase or lease distribution networks and to autonomously manage them, or be considered as CDS but in any case are submitted to the general rules applying to DSOs (unbundling, third party access,[43] etc.), and to their exemptions [44]. Finally, Member States are bound to ensure that CECs can access all electricity markets directly or through aggregation, are treated in a non-discriminatory and proportionate manner in their activities (final customers, producers, suppliers, DSOs, aggregators), are financially responsible for the imbalances they cause in the electricity system, by balancing themselves their part of the network or by delegating it, and are considered as active customers when they self-consume electricity [45]. In conclusion, CECs will have a wide diversity of profiles depending on their composition and on the activities each CEC will undertake, but they will be considered as full market actors in the system, with their rights and their obligations, which are not very different from the ones of the classic actors.

Additionally to the CECs, a new and quite similar mechanism is proposed in the 2019 RES Directive: the Renewable Energy Community (REC).

Starting with its definition in article 2 (16) of the RES Directive, the REC is almost identical to the CEC. In effect, a REC is a legal entity, "based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity". The only differences with the CEC is the mention of the autonomous character and the field of action explicitly limited to renewable energy, while a CEC can act in "electricity generation" without limit of energy source. The REC shareholder or member can be "natural persons, SMEs or local authorities, including municipalities", and "the primary purpose" of a REC "is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits", just as for a CEC.

Concerning the legal regime for RECs, article 22 of the Directive is also almost copying CECs' provisions. Its main characteristics are the following: final customers are entitled to participate in a REC "while maintaining their rights or obligations as final customers" and shall not be discriminated as soon as their participation to the REC "does not constitute their primary commercial or professional activity"[46]. Concerning its activities, they are focused on producing, consuming, store and/or selling renewable energy, to share it within the REC and to access all suitable energy markets in a non-discriminatory manner [47]. The difference with CECs is here marked by the absence of grid activities, although electricity sharing is to some extent related to it. However, when it comes to the duties of Member States to provide an enabling framework for the development of RECs (supposedly based on the compulsory "assessment of the existing barriers and potential of development of renewable energy communities in their territories"[48]), the RES Directive appears more proactive than the Electricity Directive. Indeed, the first measure mentioned in an open list of various provisions Member

States have to implement is to remove “unjustified regulatory and administrative barriers to” RECs [49]. A measure which, when combined to the obligation for Member States to “take into account specificities of renewable energy communities when designing support schemes in order to allow them to compete for support on an equal footing with other market participants” [50], further explained in recital 26, highlights this push from the Directive for an enhanced development of RECs. Finally, Member States have to adopt measures essentially guaranteeing that RECs are treated as other actors undertaking the same activity (the rules for suppliers apply to RECs supplying energy, etc.).

CECs and RECs constitute therefore an opportunity for the entrance of new actors into electricity markets, mainly attached to a notion of proximity and involvement of local actors (mainly but not only citizens). However, the provisions of the Electricity and RES Directives for these new actors offer only very limited exemption towards the classic liberalised electricity market rules, with principles such as third-party access remaining compulsory.

Now that liberalised electricity market rules and their exceptions have been presented, in the next paragraphs they will be applied to the SMILE islands.

2.3 Market Liberalisation on the SMILE islands

The above rules and possible exemptions may be relevant for the SMILE project. The situation of the three islands included in the project differs, as some are for example not connected to mainland grid or only with a connection with limited capacity. In the paragraphs below, some relevant aspects of the SMILE islands energy system will be presented as well as details about how market liberalisation rules apply to them.

2.3.1 The Orkneys

According to deliverable D2.1 “Schematic and technical description of Orkney DSM system architecture”² of the SMILE project:

The Orkney distribution network is connected to the Scottish mainland network via two 33kV submarine cables. SSEN (Scottish and Southern Energy Networks) are the DNO for the area, as well as the rest of the north of Scotland [...]. This allows generators in Orkney to export electricity to the Scottish Mainland as well as importing when there is no generation [51].

And:

April 2015 was the last month where the Islands required a net import of electricity, with 2016 seeing Orkney producing approximately 120% of its electricity needs from wind [52].

The factual situation of the archipelago of the Orkneys needs to be studied on the basis of the Electricity Directive’s provisions to determine if it can be considered as a small isolated system (SIS), a small connected system (SCS) or none of the two. Hence, the annual electricity consumption as well the share derived from Orkneys interconnection with the mainland system needs to be analysed.

² <https://www.h2020smile.eu/wp-content/uploads/2018/06/Deliverable-D2.1.pdf>

Concerning the total annual consumption, it seems that it was way under 3000 GWh in 1996, fulfilling this requirement of articles 2 (42) and 2 (43) of the Electricity Directive [53]. Yet, the 5% import criterion interpretation is open to debate as stated before in section 2.2.3. It appears from a 2005 energy audit that the Orkneys received 73% of their total consumption through the cable linked to mainland Scotland in 1995, and with no sign of a significant change in 1996 [54]. If the 5% threshold is interpreted with reference year 1996, then the Orkneys could be considered as an SCS, potentially allowing exemptions from the liberalised market. On contrary, if the 5% requirement is assessed on the basis of another year (hence actualised every year), the 2016 positive balance with mainland Scotland changes this situation. Locally available renewable electricity sources completely reversed the situation since 1996 transforming the Orkneys into a net exporter of electricity. Thus, the Orkneys could in principle be considered as an SIS under the Electricity Directive. Subsequently, some significant requests for exemptions could be addressed to the European Commission, such as having a vertically integrated DSO operating in these islands. However, currently the Orkneys' DSO is the company SSEN, which is also the DSO³ for Northern Scotland (and South England). This company claims a total of close to 3 million customers served by its grid [55]. Additionally, as SSEN's mother company is SSE [56], an energy producer and supplier, the group is already unbundled with the network part separated from the generation and supply part. Yet, SSE could decide to create another distribution branch specifically for the Orkneys, this one bundled, which could operate some generation and storage facilities on the archipelago. For the moment, it is SSE, and not SSEN which owns (partially) and operates a wind farm on Sanday island, part of the archipelago [57]. The Orkneys island are therefore currently applying market liberalisation rules.

Regarding the earlier mentioned derogation concerning the "substantial problems for the operation of" an SIS or an SCS (in section 2.2.3), there is little chance that the Commission will be in favour of this exception allowing the local grid to get exempted from the core liberalisation rules (freedom of choice of a supplier, third party access...). Effectively, the Orkneys' electricity system seems to run rather well, outside of its congestion issues, which might not be considered as "substantial problems" [58].

2.3.2 Samsø

According to deliverable D3.1 "Specifications and Data Report for the Samsø Demonstrator"⁴ of the SMILE project: "Samsø has cables to the mainland, and there is an exchange of power both ways, but it is mostly export", and "The island often has excess electrical power and therefore exports renewable electricity to the mainland, Jutland, via two 60 kV connections, one (with two cables) to the West (max 40 MW in total) and one to the North (max 365 amp), forming a network ring. However, the northern cable is idle, since it is used only for backup" [59].

It therefore appears that Samsø is in a similar situation as the Orkneys, being connected to the mainland Danish grid, but consuming less than 3000 GWh and exporting electricity on an annual basis, with reference 2013 [60]. And there is no sign that this situation will be reversed [61]. Hence, if we apply the yearly updated 5% criterion, Samsø could be considered an SIS. However, if the assessment is based on 1996 figures, then the closest electricity consumption we found dates back from 1997 and this year the subsea cable linked to mainland Denmark imported 95% of the electricity consumed on

³ Actually still a Distribution Network Operator (DNO), but to become a DSO by 2019. See SSEN, *Supporting a Smarter Electricity System - Our Transition to DSO*, November 2017, p. 36 [file:///X:/My%20Downloads/SSEN_Transition_to_DNO_final_10thNov_pgs.pdf].

⁴ <https://www.h2020smile.eu/wp-content/uploads/2018/06/Deliverable-D3.1.pdf>

the island [62]. Other documents seem to corroborate these figures for the 1990s decade in Samsø, before a major shift in the electricity generation pattern fostered by the expansion of wind energy on the island in the 2000s.[63] In this case, Samsø could be labelled as an SCS. However, to prove “substantial problems for the operation of” an SIS or an SCS might be even more difficult than for the Orkneys as the grid on Samsø seems to be well operated.

Regarding the distribution system, the situation is quite similar to the one in Scotland. Samsø’s grid is operated by a DSO named Konstant (until December 2017 called NRGi Net), a 100%-owned subsidiary of the unbundled energy supplier NRGi. This DSO is also operating the grid in parts of the Jutland peninsula, especially in Aarhus area.⁵ As this DSO is serving more than 200 000 connected customers [64], it cannot benefit from the ‘less than 100 000 connected customers’ exemption of article 35 (4) of the 2019 Electricity Directive. Under this threshold, a DSO can exploit the same exemption to unbundling as if it would be acting in an SIS.

2.3.3 Madeira

Due to its distance from the European coast, Madeira is in a very different situation compared to the Orkneys and Samsø.

A derogation of the unbundling rules was granted by a 2006 Commission decision [65]. Madeira, being an ‘outermost region’ of the European Union [66] located too far away from the European continent to be connected to its grid, benefits from a derogation to the application of Chapters IV, V, VI, VII, as well as Chapter III of the 2003 Electricity Directive, concerning electricity generation (authorisation procedure, tender), TSOs and DSOs’ rules, unbundling rules and access to the system rules, such as third-party access. There is then no unbundling provision applicable to Madeira, considered at that time as a ‘micro isolated system’ by the Commission [67]. With the 2019 Electricity Directive, the exemption for Madeira would be granted on the basis of article 66, as exposed earlier in section 2.2.3. As a consequence of the above, Eletricidade da Madeira (EEM) is currently at the same time the main electricity producer, the TSO, DSO and supplier on the island [68].

This case can prove useful for other islands in a similar situation in the European Union, although not all considered as ‘outermost regions’. The Aegean Sea Greek Islands are for many of them in this situation and some decisions have already been adopted by the European Commission in their regard, providing some derogations [69].

2.3.4 Application of market liberalisation rules and exemptions to SMILE islands

In addition to the assessment of the applicability of the SIS or SCS exemption for the three different SMILE islands, the possible application of the other exemptions detailed in the previous section needs to be analysed.

Concerning direct lines, one could at first glance be inspired to qualify a subsea cable connecting an island’s grid to mainland’s grid as such. Yet it is difficult to imagine an island with thousands of inhabitants being considered an ‘isolated customer’. A case of direct line could be a single wind turbine

⁵ See [www.konstant.dk \[https://konstant.dk/net/om-konstant/leveringsomraade/\]](https://konstant.dk/net/om-konstant/leveringsomraade/), accessed 2 February 2018.

connected to a single customer (being a household or a plant), but not an entire island composed of multiple final customers. Consequently, direct lines will be of limited application in the SMILE islands apart from particular cases, which are not specific to islands (industrial sites, etc.).

Regarding CDS, on European islands in general and in SMILE's sites in particular it might be possible to apply these rules. The SMILE case that seems to correspond the most with this situation is Samsø, and the Ballen marina in particular, although the Danish energy regulator did not take any decision considering this cable as a CDS. Without such a decision, this cable cannot be considered a CDS. Nonetheless, the specificity of this cable (its length, the number and diversity of final consumption points) and the possible future developments in the marina (smart metering for boat charging and individual billing) triggered our interest in finding a possible legal qualification in EU law. Below, the Ballen marina's cable is analysed to find out if it could possibly be considered a CDS or not.

The marina's electricity system consists of small generation and storage units together with multiple consumption points, all connected to a cable which is connected to the public network [70]. There is only one electricity supply contract – between the municipality (owner of the marina and its cable) and its supplier (NRGi in this case) – for all the electricity going from the distribution network to the marina's cable through the meter. As figure 1 shows, behind the meter connecting the harbour cable to the public network, there are service buildings (harbour master's office, a service building with showers), street lights, the new PV plant, the new electricity battery and the boats staying in the marina.⁶

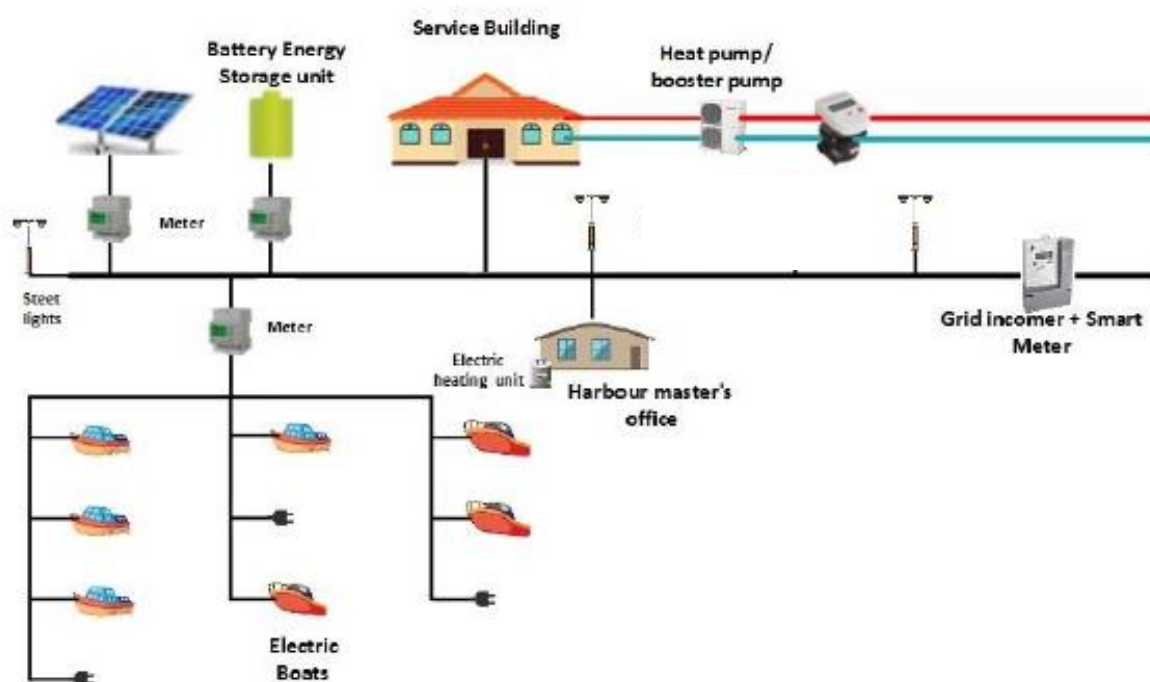


Figure 1 – Ballen marina's harbour grid scheme – Samsø (source: SMILE deliverable D3.1, p. 16, fig. 9)

⁶ In the deliverable, a seafood diner is also indicated, but ultimately it is not connected to the harbour grid. Therefore, it must not be taken into account.

Therefore, this site is similar to a camping site in many regards, with no households, many temporary customers and a cable connected to generation and storage, operated by the municipality responsible for the Ballen marina. According to these elements, the Ballen marina meets some of the requirements to be considered a CDS following article 38 of the Directive, as it can be regarded as a geographically confined commercial or shared services site, and it does not supply households. However, this “system” has to “distribute” electricity. According to article 2 (28), “distribution” means the transport of electricity through a distribution system “with a view to its delivery to customers, but [it] does not include supply”. “Supply” in this case means “the sale, including resale, of electricity to customers” [71]. In the marina, this situation is unclear. The municipality currently does not directly sell the electricity to the boat owners, its only clients (apart from the municipality itself), but it provides them with electricity without metering and billing it [72]. Therefore it is unlikely that this action would be regarded as electricity supply. Moreover, the municipality is not recognised as an electricity supplier (it does not have a licence). This part of the definition is thus already problematic.

However, the second part of the requirements in article 38 must also be satisfied, meaning that either “for specific technical or safety reasons, the operations or the production process of the users of that system are integrated; or that system distributes electricity primarily to the owner or operator of the system or their related undertakings.”

Concerning the first option, it seems that with this system being fed by electricity from a PV plant connected to a battery, it might be possible to consider that “the production process of the users of that system are integrated”. However, to prove that it is for “specific technical or safety reasons” constitutes an issue. To try to qualify the marina as a CDS on this basis would result uncertain. Concerning the second option, we must analyse who consumes the distributed electricity (while keeping in mind that the term “distribution” does not seem to apply in our case). To date, there is no reliable full-year data to separate the consumption of the operator of the grid (the municipality, with the harbour master’s office, the service building and the street lights on the grid) from the consumption of the other final customers: the boat owners. To make an attempt, we can refer to figure 2 below, displaying the weekly consumption from the entire harbour, including the boats’ share. This graph shows clearly that most of the electricity consumption on the harbour comes from the boats themselves.

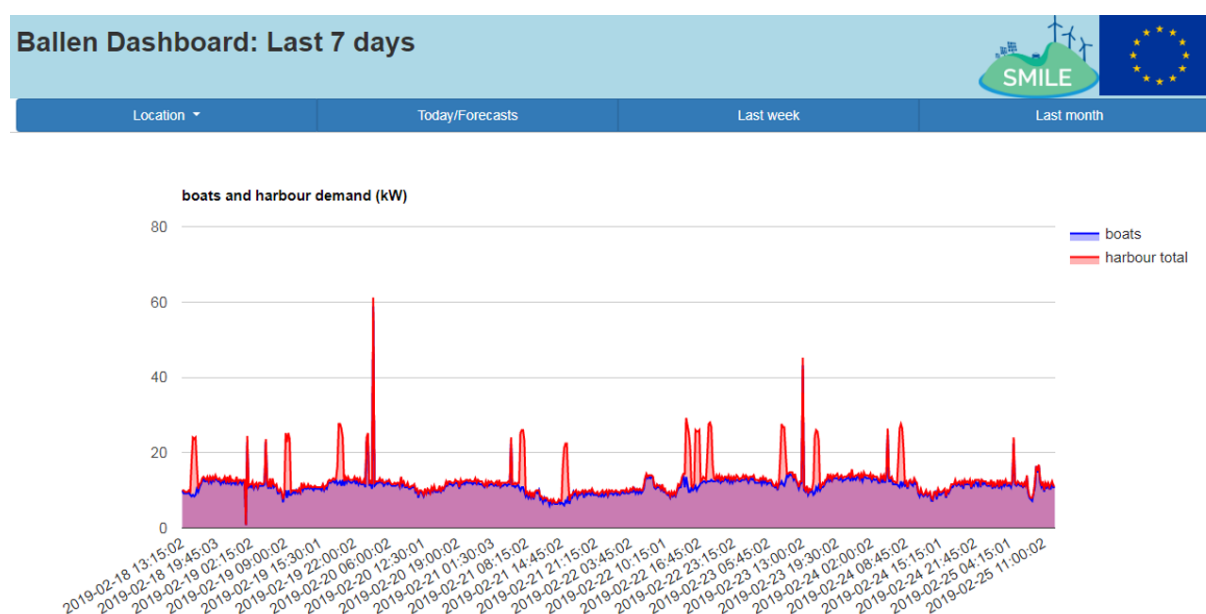


Figure 2 – Electricity consumption of the Ballen marina – Samsø
(source: <https://plangreatly.com/dashboards/ballen/lweek.php> accessed 25 February 2019)

There are two options from this point onward. The first one is to consider that owners as the final customers of the electricity passing through the local grid, meaning that they directly pay an electricity bill for this. However, earlier it was already established that that is not the case. With this option, the CDS qualification would not apply and boat owners would be entitled to freedom of choice of their electricity supplier. The second option is to consider that the harbour cable only provides electricity to the municipality that owns and operates it. In that case, the municipality pays its supplier for the total electricity consumption of the marina and provides the electricity to the boats as part of a commercial package, including electricity as well as the rental of the harbour spot and perhaps other services (such as access to the harbour sauna), just like for public charging stations for EVs [73]. In this case, the boat owners do not receive a separate electricity bill and we could see the municipality as the final customer, thus opening the window for a CDS qualification for the grid of the Ballen marina.

The result of this analysis is a deadlock situation. Either the boats are considered final customers, in which case the cable behind the meter to the public grid forms a (closed) distribution system. As a consequence, the municipality has to become an electricity supplier, which comes with its own set of rules and which submits it to competition with other suppliers while the boat owners would still enjoy the freedom of choice of suppliers [74]. Or the boats are not considered the final customers, meaning that the municipality is the final customer. In this situation, the municipality does not bill the boat owners for their consumption, but the cable behind the meter is not a distribution network. It is this last option which clearly prevails, excluding a potential qualification of CDS for the Ballen marina as it is.

Finally, a brief remark concerning energy communities. On Samsø, like on the Orkneys, a part of the local inhabitants invested in the development of renewable energies years ago, particularly in wind energy [75]. While it would require an in-depth analysis of the composition of the capital and of the decision power that the local investors retain in the operation of these wind turbines to assert or reject the character of an REC (and maybe a CEC), this falls outside of the scope of this deliverable. Nevertheless, it shows that these communities are already forming a type of energy community, and it confirms that the new CECs and RECs offer great potential for the SMILE islands and for numerous other territories in Europe. For islands, due to their remoteness and to the inherent hurdles in the development and operation of a locally adapted and economically beneficial energy system, it is possible to expect a higher propensity for community action in this field. CECs or RECs could then easily spread quickly among islands, powering neighbourhoods and towns and creating a network of increasingly empowered communities.

Overall, this section has shown that electricity market liberalisation rules can apply differently to EU islands due to their distance from the coast and the characteristics of their electricity system. Indeed, to assess whether an island's electricity system can benefit from exemptions from market liberalisation rules, its level of use of its interconnection with the mainland's electricity network (ratio import/export) is a key aspect. This has also been confirmed by an EU-wide study realised with islands in many EU countries regarding their level of market liberalisation. The detailed results of this study can be found in annex 1 of this deliverable. However, a wide majority of EU islands, and specifically the SMILE islands, are interested in electricity storage to help balance their grid with an increased RES-based generation. The following section will therefore assess the issue of electricity storage from its technological options to its legal EU regime.

2.4 Summary

The first section of this deliverable presented the EU legal framework governing liberalised electricity markets and its exemptions to unbundling rules. Apart from a general introduction with regard to these two issues, the focus has been on the way in which they are applied to (the SMILE) islands.

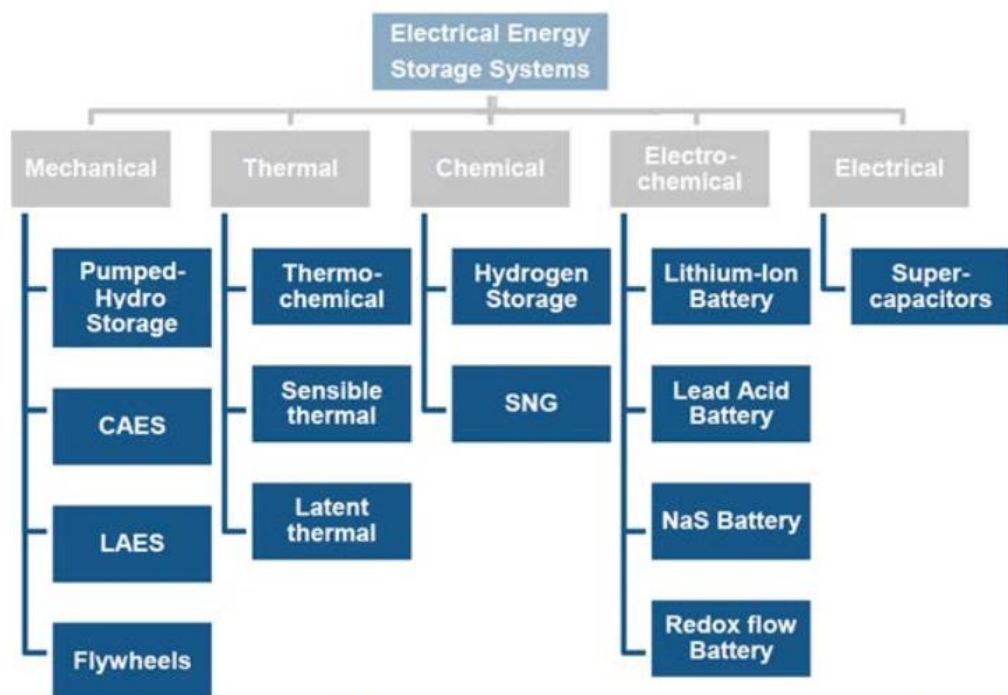
In a nutshell, the SMILE islands provided an interesting testing ground for the different legal situations that EU islands can face in their transition towards renewable energy. Firstly, it should be noted that the SMILE islands have different characteristics as some of them are connected to the mainland's grid (the Orkneys and Samsø) and hence apply the same rules as in the rest of the country, and others are not connected to the mainland (Madeira) and thus have been able to benefit from a derogatory regime in terms of market liberalisation. This variety ensures a higher possibility for replicability of this experience to other islands. Secondly, the three islands studied provide examples of exemptions to the general regime applied in the EU regarding system operation, namely CDS, isolated systems and perhaps in a close future citizens and renewable energy communities. CDS was first seen as a possible option to legally qualify the Ballen marina's cable behind the meter to the distribution network in Samsø, but a thorough study showed that it was unlikely that such a qualification could take place as it is. On the contrary, isolated systems, which have been modified by the 2019 Electricity Directive, are likely to apply to the Orkneys and Samsø, even if these islands have not been granted such a status still (they have not requested it). The striking element in this case is that it is the energy transition towards 100% renewable electricity consumption on these islands which creates the opportunity for them to perhaps in the future be considered as isolated systems as they gain reinforced energy autonomy and could then benefit from some market rules exemptions. Last but not least, the research has shown that these three islands could be ideally situated to implement the new provisions on citizens and renewable energy communities located in the 2018 Renewable energy Directive and the 2019 Electricity Directive given the existing involvement of citizens in RES projects (particularly the Orkneys and Samsø).

3 European Union legal framework for electricity storage and SMILE islands

In order to accompany the development of new renewable sources of electricity (mainly wind and solar) and to cope with their variability, electricity storage is on the rise worldwide. In this section, the different types of potential and existing electricity storage technologies will be presented before focusing on the storage technologies applied on the SMILE project islands and how they fit into the market design presented above. Thereafter, the new regulation for electricity storage adopted by the 2019 Electricity Directive is presented and assessed as well as its potential impact on the SMILE islands.

3.1 Introduction on storage technologies

As figure 3 shows, there are five categories of electricity storage technologies, each of them being subdivided in various sub-technologies. For each of these individual technologies, a different range of energy storage capacity (from kW to MW) and discharge time (from seconds to hours or more) applies. These characteristics have a strong impact on the way storage options can be used to accommodate the integration of higher shares of variable renewable sources to the electricity network. Figure 4 gives an overview of the characteristics of the most developed technologies or of some of the ones with the higher potential.



CAES = Compressed Air Energy Storage; LAES = Liquid Air Energy Storage; SNG = Synthetic Natural Gas.

Figure 3 – Electricity storage technologies (source: Commission staff working document, Energy storage – the role of electricity, 1.2.2017 SWD(2017) 61 final, p. 9)

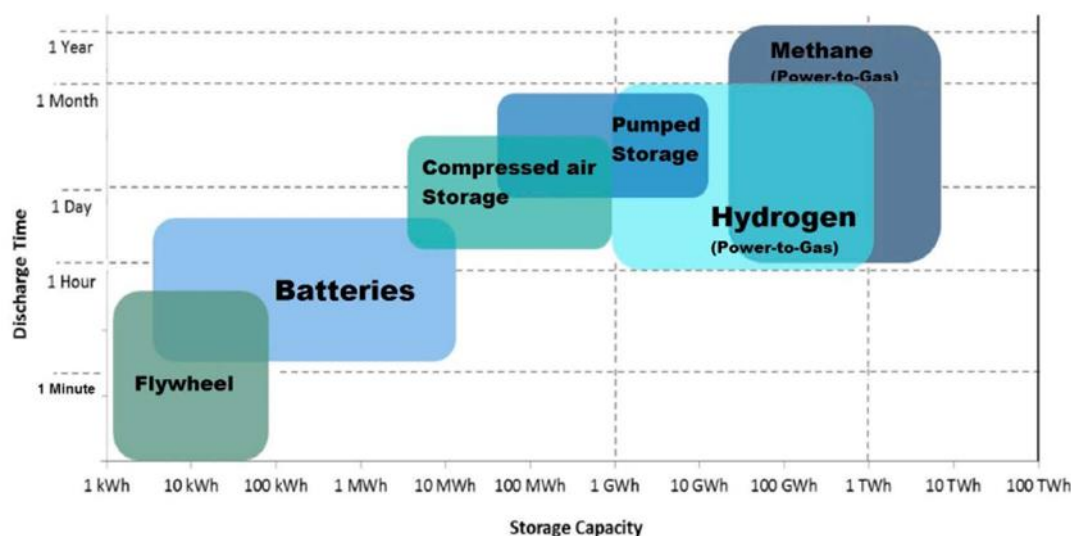


Figure 4 – Capacity and discharge time of some electricity storage technologies (source: Commission staff working document, Energy storage – the role of electricity, 1.2.2017 SWD(2017) 61 final, p. 12)

Each technology or category of technologies is characterised by a different level of development. Currently, pumped hydro storage (PHS) is by far the most used technology, totalling around 150 GW of installed capacity in 2016 [76]. In comparison, in the same year all other storage types together did not reach 7 GW. More particularly, electric battery storage just reached the 1 GW threshold 2 years before [77]. Nevertheless the focus is on the latter technology given its potential in 2030 [78].

It is to be noted that Battery Electricity Storage Systems (BESS) are not only used in large scale connected to a generation site or directly to the grid, or a small scale in households. Electric Vehicles (EVs), if in sufficient numbers, can also be used as a storage option for the grid, it is then usually called Vehicle-to-Grid [79].

Aside from battery technologies, Power-to-X (P2X) is a strong development axis for the energy transition. This term refers to the process of converting electricity into another energy carrier, mostly gas (hydrogen, methane), then called Power-to-Gas (P2G) [80] or heat, then referred as Power-to-Heat (P2H). It potentially allows to make use of excess renewable electricity produced during high production periods, hence avoiding losing it or some grid problems such as local congestion. If reconverted later to electricity (a theoretical possibility but not the most energy efficient) it can then be considered as a way to store electricity.

Prior to the CEP, there were no provisions in EU law governing electricity storage. Despite the absence of such framework, electricity storage has been developed by Member States which sometimes also initiated a dedicated legal framework, as the cases of Italia or Germany show [81]. However, when considering these national developments, two approaches can be noted. Electricity storage is either developed by system operators (TSOs/DSOs) or by commercial parties (producers/suppliers/consumers). The EU legislator was faced with a similar choice when drafting the provisions in the package, inspired by various reports and policy documents highlighting the need for a proper legal framework dealing with electricity storage [82].

As a result, the 2019 Electricity Directive mentions electricity storage dozens of times in order to integrate it to the electricity market. The most symbolic example is that storage has been included in article 1 of the Directive, as it now “establishes common rules for the generation, transmission, distribution, storage and supply of electricity”.

Another text from the CEP, the regulation (and not directive) on the internal market for electricity, also participates to this integration of energy storage to the electricity market [83]. In recital 22, it is stated that network tariffs “should not discriminate against energy storage, and should not create disincentives for participation in demand response [...]”. A bit further, article 3 (1) (i) mentions that “safe and sustainable generation, storage and demand shall participate on equal footing in the market [...]”. Explicitly, in article 16 paragraph 1, “[c]harges applied by network operators for access to networks, [...] shall not discriminate either positively or negatively against energy storage and aggregation and shall not create disincentives for self-generation, self-consumption and for participation in demand response.” Although these provisions do not mention clearly any obligation to end double payments, they increase the pressure to terminate these barriers currently present in many Member States. Finally, and more broadly, regulatory distortions removal and market failures fixing concerning energy storage is targeted by article 18 (3) (e) of the regulation.

Below we will discuss the provisions in the 2019 Electricity Directive. Following a discussion of the definition of electricity storage, we will examine who is entitled to develop and operate electricity storage, and thereafter what this means for the islands.

3.2 EU general legal framework for electricity storage

In the following paragraphs, we will analyse the existing and forthcoming EU legal framework for electricity storage, including a variety of technologies that can be used for this purpose: from batteries to P2G, P2H and EVs.

3.2.1 Definition

The first and main problem for electricity storage development until 2019 was that it was not mentioned, let alone defined, in the 2009 Electricity Directive. The same observation can be made regarding EVs and hydrogen or heat storage and the Power-to-X (P2X) process. Yet, in 2009, the RES Directive was adopted [84], explicitly mentioning storage and its key role in integrating a higher share of renewable energy production into the grid [85].

Aside from creating legal uncertainty, this lack of definition led to double payments. Indeed, as storage facilities need to first consume electricity to replenish their capacity, before generating electricity in a second time when feeding it into the grid, they are submitted to the fees and taxes related to each of these two phases. Since some of the electricity storage technologies with the highest potential (like Lithium-ion batteries) are just becoming competitive, double payments constitute a barrier to their deployment.

This situation is changing with the CEP. In order to provide a stable and appropriate framework for the development of electricity storage, the Directive defines energy storage ‘in the electricity system’ as:

Deferring the final use of electricity to a moment later than when it was generated, or the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carrier [86].

This definition has two parts. Firstly, electricity storage can take place when the final use of electricity is deferred to a later moment than when it was generated. This part has two consequences: it allows to consider super-capacitors, which store electricity in an electric field without conversion to another energy carrier, to be considered, and it introduces a clear difference between the storage stage and the generation and consumption stages, hence tending to avoid double payment. Storage is now considered a clear step in the energy chain, not to be confused with generation or consumption. Secondly, electricity can also be converted into another energy carrier, then stored and either reconverted back to electricity (such as with a chemical battery) or used in the form of a different energy carrier (such as in P2G). For this last option, the final energy carrier can be the same as the one used during storage (e.g. electricity converted to hydrogen and then used as hydrogen) or can be another one (the hydrogen produced would be turned into methane by adding CO₂ and used under this form) [87]. This second part also clearly makes a difference between the generation of electricity in the first place, its storage and its consumption in the end, which should help end double payment and unbundling issues (touched upon in the following section). All in all, this long-awaited definition of storage seems satisfying as it is broad enough to encompass the different families of electricity storage technologies, to develop all the potential of P2X solutions, and to end double payments by considering storage as a specific stage in the energy chain, an interpretation crowned by article 1 of the Electricity Directive mentioning storage alongside with but independently from generation, transmission, distribution and supply of electricity.

3.2.2 Operation of storage facilities (including public EV charging station)

With the 2009 Electricity Directive, TSOs or DSOs which were interested to own or operate storage facilities did not benefit from an encouraging legal framework. According to the unbundling rules seen in section 2.1.1 of this deliverable, network operators cannot get involved into generation activities, apart for some exceptions such as small isolated systems, and consequently cannot own, operate or manage storage facilities under the legal framework established in 2009. However, unbundling rules for TSOs and DSOs can have a strong impact on storage technologies kick-starting. Indeed, network operators are the first interested to test these solutions, instead of having to reinforce or extend their grids – a costly operation. They would be willing to invest in these assets, but cannot if storage is considered as generation.

Under the CEP, a legal framework for the operation of electricity storage facilities has finally been designed. Interestingly, these rules are integrated in the 2019 Electricity Directive via articles focusing on TSOs (art. 54) and DSOs (art. 36), revealing the essential role network operators have to play on the deployment of these facilities.

In article 54 (1) of the Directive, TSOs “shall not be allowed to own, develop, manage or operate energy storage facilities”. The general rule is then prohibition. However, the rest of the article provides a restricted regime of exception allowing TSOs to own, develop, operate or manage storage facilities based on two sets of rules. The first option is that the storage facilities are “fully integrated network components and the regulatory authority has granted its approval”[88]. Fully integrated network components are defined in article 2 (51) as “network components that are integrated in the transmission or distribution system, including storage facility, and that are used for the sole purpose of ensuring a secure and reliable operation of the transmission or distribution system, and not for balancing or congestion management.” This definition aims to limit the storage facilities TSOs can directly handle to usually small-sized equipment which cannot be used for balancing of congestion management, hence not for making any money but only for direct security of the grid reasons. The second option presented in article 54 (2) presents a list of conditions cumulative conditions:

(a) other parties, following an open, transparent and non-discriminatory tendering procedure that is subject to review and approval by the regulatory authority, have not been awarded with a right to own, develop, manage or operate such facilities, or could not deliver those services at a reasonable cost and in a timely manner.

(b) such facilities or non-frequency ancillary services are necessary for the transmission system operators to fulfil their obligations under this Directive for the efficient, reliable and secure operation of the transmission system and they are not used to buy or sell electricity in the electricity markets; and

(c) the regulatory authority has assessed the necessity of such a derogation, has carried out an ex-ante review of the applicability of a tendering procedure, including the conditions of the tendering procedure, and has granted its approval.

The regulatory authority may draw up guidelines or procurement clauses to help transmission system operators ensure a fair tendering procedure.

Additionally, the regulatory authorities (NRAs):

Shall perform, at regular intervals or at least every five years, a public consultation on the existing energy storage facilities in order to assess the potential interest of other parties in investing in such facilities. Where the public consultation, as assessed by the regulatory authority, indicates that other parties are able to own, develop, operate or manage such facilities in a cost-effective manner, the regulatory authority shall ensure that [TSOs]' activities in this regard are phased-out within 18 months. As part of the conditions of that procedure, regulatory authorities may allow the [TSOs] to receive reasonable compensation, in particular to recover the residual value of their investment in the energy storage facilities [89].

Finally, this paragraph on periodic reassessment does not apply to:

Fully integrated network components or for the usual depreciation period of new battery storage facilities with a final investment decision until 2024, provided that such battery storage facilities are:

- (a) connected to the grid at the latest two years thereafter;
- (b) integrated into the transmission system;
- (c) used only for the reactive instantaneous restoration of network security in the case of network contingencies where such restoration measure starts immediately and ends when regular re-dispatch can solve the issue; and
- (d) not used to buy or sell electricity in the electricity markets, including balancing [90].

As a consequence, under the new EU legal framework, TSOs are not allowed to own, manage or operate storage facilities unless: they are an integrated components of the grid which do not serve for balancing or congestion management, or a tender is organised but results unsuccessful although it constitutes a necessary equipment for the TSO not used to buy or sell electricity on the market, all of this under control of the NRA. And in any case, this limited derogation is only temporary.

The first exception for “fully integrated network components” excluding balancing and congestion management and the obligation to organise a tender for other kinds of electricity storage facilities leaves almost all of the storage needs to realise the energy transition towards increased use of renewable energy sources in the hands of the market and therefore contributes to considering electricity storage as a commercial activity instead of a regulated one. Hence the important role to be played by NRAs in controlling that electricity storage is treated as a commercial activity.

Concerning the obligation of periodic reassessment of the willingness (and capacity) of other actors to operate the storage facilities, the perspective for TSOs to have 18 months to transfer the equipment and to “receive reasonable compensation, in particular to recover the residual value of their investment in the energy storage facilities” is to be highlighted as it constitutes a factor of legal certainty and foreseeability for TSOs’ investments and could help kick-start energy storage grid-applications while not imperilling the development of a competitive market for the commercial activity of energy storage. However, the exception to the exception developed in the paragraph following the periodic reassessment seems to aim at providing a kind of transition period for fully integrated network components or for the depreciation period of new BESS but with such a long list of conditions clearly limiting the use of this provision that it appears quite complex.

For DSOs, the provisions of article 36 of the Electricity Directive are almost a carbon copy of TSOs’ ones. The only one which seems to be impactful is in paragraph 4 of the article, where the exception to the exception as seen before for TSOs is in this case limited for new batteries to those with a final investment decision taken “until the entry into force of this Directive”, so various years earlier.

As a result of the above two pages of assessment, it appears clearly that the 2019 Electricity Directive considers energy storage in the electricity system as a commercial activity and not a regulated one (save for very limited exceptions), therefore framing heavily the action of TSOs and DSOs in this field.

Before to end this section, it is important to mention EVs and recharging points as they can constitute electricity storage solutions as mentioned earlier. The main directive on this issue dates back from 2014 and concerns the deployment of alternative fuels infrastructure [91]. It is its article 4, paragraph 8, that sets the regime for the interplay between the electricity supplier, the recharging station operator and the EV user. It considers that freedom of choice of a supplier concerns the recharging station operator and not the EV user willing to charge its car. In a few words, the operator of the station chooses an electricity supplier and then the operator provides “electric vehicle recharging services to customers”. The operator is not a supplier, it does not sell only electricity but a package comprising the electricity consumed, but also the rental of the parking lot (and maybe other services). However, the operator can potentially be part of an electricity supply entity. According to the directive, “prices charged by the operators of recharging points accessible to the public are [supposed to be] reasonable, easily and clearly comparable, transparent and non-discriminatory”, and it is the task of Member States to control that [92]. Therefore, as we understand it, the competition in the public charging stations market should be ensured by the transparency of the prices, allowing customers to choose beforehand in which station they will stop to buy a recharge package comprising at least a parking lot and some electricity.

In the 2019 Electricity Directive, article 33 is dedicated to the “[i]ntegration of electromobility into the electricity network”. In practice, these provisions clarify the role of DSOs vis-à-vis recharging points for EVs. In a nutshell, DSOs are prohibited to own, develop, manage or operate recharging points for EVs, save for private recharging points owned by DSOs “solely for their own use”. The similarity with electricity storage provisions is striking and underlines the proximity in terms of role in the electricity system between electricity storage and EVs recharging points. The exception to this principle works out in a similar way as for storage, with a list of cumulative requirements combining an unsuccessful tender controlled by the NRA and a relatively new point constraining DSOs to “operate the recharging points on the basis of third-party access [...]”[93]. As a consequence, the DSO owning and operating a recharging station will have to select an electricity supplier on a non-discriminatory basis, “in particular in favour of its related undertakings”[94]. Here as well, the same mechanism of regular reassessment is included with the phasing-out of the activity if candidates are selected, but there is no timeline

mentioned for this phase out. Finally, the DSO which would have to let its recharging infrastructure could also recover “the residual value of its investment” [95].

Alongside with this EU regime, Member States also have to “provide the necessary regulatory framework to facilitate the connection of publicly accessible and private recharging points to the distribution networks”, with full and non-discriminatory cooperation from the DSOs. Some national developments are then to be expected on this side [96].

As a result of this revamping of the European legal and regulatory framework for electricity, the technologies dedicated to its storage (EV recharging points included) benefit from an improved legal certainty. Overall, the general rule for electricity storage will be that it is a commercial activity (and not a regulated one), then submitted to the rules of a liberalised market with free competition. However, TSOs and DSOS will still be able to act in this field until the conditions for a profitable activity are met (also related to a fair value for storage on the market and the question of double grid fees payments).

Hopefully, this new legal framework will support the Commission’s finding presented in a 2017 Commission staff working document, concerning particularly islands:

“Studies show that an electricity system with a large share of variable RES appears to be more cost efficient with storage than without storage. That is even more apparent in an island system with high share of variable RES” [97].

In the following section, we will assess the application of this set of rules still under debate for the SMILE islands.

3.3 Application to the SMILE islands

On the islands taking part in the SMILE project – Madeira (PT), the Orkneys (UK) and Samsø (DK) – three different types of electricity storage technologies are being installed and tested: battery storage, electric vehicle charging (with batteries), and P2X. For each, we briefly characterise the storage installation before to assess if it follows the new electricity rules of the 2019 Electricity Directive. In addition, various examples of electricity storage facilities deployed in other EU islands than the SMILE ones are described in Annex 2 to this deliverable, in order to underline the variety of technologies that can be used for electricity storage on islands.

3.3.1 Battery storage (and EVs) in the SMILE project

Battery Energy Storage Systems (BESS) are on the rise worldwide [98], thanks to their versatility – they can be installed everywhere and vary in size, from a few kW/kWh to multiple MW/MWh. The biggest battery storage installation worldwide currently running is located in South Australia and has a capacity of 100 MW/129 MWh [99]. Due to this versatility, BESS are installed and being tested in all three islands of the SMILE project.

On the Orkneys, small BESS (7.5 kWh) are used in combination with heat pumps and heat storage devices installed in houses [100]. The BESS is specially designed to absorb excess wind turbines electricity generated which would otherwise be curtailed. When optimum, the electricity stored in the battery is used to feed the heat pump and the heat storage [101]. This installation is not piloted by network operators but directly by one of the project’s partners, OVO-Energy, through its aggregating

platform which will be controlling the batteries based on the household demand and other criteria for charging such as a curtailment event or low energy price. The BESS will be owned by another partner, Community Energy Scotland (CES). There is therefore no issue of compatibility between the new EU legal regime for electricity storage and the ownership and operation of corresponding installations on the Orkneys. Additionally, it is to be noted that this system corresponds to demand response, a scheme mentioned dozens of times in the new Electricity Directive which heavily supports its widespread use and especially by aggregation [102].

In Samsø, a BESS of a higher capacity (240 kWh) has been installed on the project site (the marina), to store the excess solar power produced by a new photovoltaic (PV) plant (60 kW), hence aiming to feed the port's facilities and the tourists' boats even during evening and night times [103]. The battery is not operated by grid operators either but by the municipality. There is therefore no issue of compatibility between the new EU legal regime for electricity storage and the ownership and operation of corresponding installations on Samsø.

Finally, in Madeira, different kinds of BESS are installed. Firstly, small-sized BESS (3 kW/8.6 kWh) are to be installed and tested to allow consumers to store the excess electricity produced by their PV panels during mid-day, when production is high but household consumption low, or to recharge the BESS from the grid during off-peak periods [104]. Secondly, a bigger-scale BESS (40 kW/80 kWh) has been installed at a transformation station owned by the DSO to provide grid balancing and frequency or voltage control services [105]. This asset is owned and operated by the DSO itself, but this is not an issue under EU Law as Madeira benefits from a derogatory regime as mentioned earlier in section 2.3.3.

Parallel to BESS, another type of storage used on the SMILE islands is by the use of electric vehicles. In principle, the batteries in electric vehicles need to be charged on a regular basis and can thus also be used to store (excess) electricity and to reinject it to the grid when needed. As such, EVs can then be considered as mobile battery storage facilities in addition to stationary ones. If a pool of electric cars of a sufficient size is combined with a controllable system of electric charging, it allows to provide grid services and can be considered as dispatchable storage. That is why, as seen before in section 3.2.2, EVs charging is considered as a commercial activity by the 2019 Electricity Directive.

SMILE islands integrate electric vehicles and so-called 'smart charging' (charging the vehicle's battery when electricity prices are lower when doable) into their demonstration projects, but from different perspectives. The Orkneys are implementing smart charging devices for cars owned by households primarily for the purpose of wind energy curtailment reduction [106]. The charging points are operated by OVO-Energy and RouteMonkey, two private companies part of the SMILE project [107]. Vehicle-to-Grid, or the injection of electricity from the vehicle's battery to the grid falls outside of the scope of the project. In Samsø, electric charging only concerns the consumption of the tourists' boats when docked at the marina but no electric cars for the moment although this option was studied [108]. The injection of electricity from the boats to the grid is not mentioned as an option either. Lastly, in Madeira, smart charging devices are being installed at the EEM garage for their own vehicles and at a local business that provides small guided tours (with 6 electric scooters, namely Ape Calessino scooters) in order to assess the economic impact of EV charging from the grid in periods of low prices [109]. In this case, again, electricity injection to the grid is not considered. As a consequence, there is no breach to the new EU legal framework for ownership or operation of EV charging stations by DSOs on the SMILE islands.

3.3.2 Hydrogen and heat storage in the SMILE project

P2X, briefly presented in section 3.1 is developed in only one SMILE partner island: The Orkneys. Firstly, an electrolyser was installed for P2G purpose, however, it was the result of other projects funded by the Scottish Government: Surf 'n' Turf and BIG HIT [110]. In the frame of the SMILE project, this electrolyser acquires the “smart switching” capacity in order to more efficiently use the power delivered by tidal and wind energy on one of the Orkneys islands. This system is therefore also making use of demand response and falls under the definition of electricity storage according to the Electricity Directive, by converting the electricity into hydrogen, which is then transported to another island where it is reconverted into electricity in a fuel cell for use in local ferries. As the owner of the electrolyser is a private company (EMEC) and not a network operator, there is no issue regarding the rules seen before in section 3.2.2. Same for its operation which is done by the owner and/or the company installing the smart device [111]. Secondly, Power-to-Heat (P2H) is used for storing excess renewable energy production and feed the houses' central heating system or deliver hot water [112]. It is a sort of derived electricity storage, as it allows to consume the electricity which would otherwise be lost because of grid congestion issues, and to avoid electricity consumption later in the day, when the production might not be sufficient.

Although the issues specific to the regulation of electricity and heat sectors coupling are analysed in deliverable D7.2, these installations are submitted to the same usual questions as for BESS. Actually, they seem to fall under the definition of electricity storage seen earlier, as the electricity is stored as a different energy carrier (heat) and then used as such. The regime switches then from electricity storage to heat supply, but at least in the first phase (electricity consumption by the equipment to produce heat), the Electricity Directive rules shall apply, limiting the ownership and operation of these facilities. Fortunately, the heat batteries and hot water storage in the Orkneys are owned respectively by Sunamp (the supplier) and CES and both are operated by OVO-Energy [113], so not by grid operators.

3.4 Summary

The second section of this deliverable presented the new EU legal regime for electricity storage. Following an introduction on the different existing or potential electricity storage technologies, the main development of this section presented the definition, ownership and operation regime for electricity storage stemming from the 2019 Electricity Directive, and its application to the SMILE islands.

The research undertaken for the SMILE project can give helpful feedback on the development of storage, being by using batteries, smart EV charging, or P2X as all these technologies and services are tested there. Islands will, due to their usually higher costs for generation and grid balancing, benefit from the legal clarity offered by the new Electricity Directive, which besides defining electricity storage also addresses the issue of double charging (although only indirectly). Most importantly, the 2019 Electricity Directive now explicitly states that electricity storage is a commercial activity, henceforth open to competition and thus restricted (apart for a limited list of reasons) for network operators. In addition to this analysis, it is to be noted that the 2019 Electricity Directive complements the 2014 Directive on the deployment of alternative fuels infrastructure. EV smart charging deployment should benefit from the intertwined emergence of a legal framework for electric mobility to be increasingly used as a part of the storage system.

4 National legal frameworks for electricity storage on SMILE islands

Although the directives adopted by the EU provide a general legal framework for the organisation of the electricity system of its Member States, their national implementation varies according to the local context. Therefore, it is paramount to analyse the national and, if necessary, the local legal and regulatory frameworks applying to the issues raised by the SMILE project and especially concerning electricity storage.

The following paragraphs will successively study the national legal frameworks that apply in the UK, Denmark and Portugal on electricity storage technologies deployed on the SMILE islands: electricity storage by stationary equipment (batteries and P2X) and by the use of EVs smart charging. When appropriate, we will also examine the legal and regulatory documents at a regional level (such as for Scotland) and at the island level (such as on Madeira). In addition, a short description of the legal regime for electricity storage on islands from other EU Member States not already presented in the deliverable is provided in Annex 3 to this document.

4.1 The Orkneys – United Kingdom

The UK is a unitary state which has devolved significant legal and executive powers to its countries: England, Wales, Northern Ireland and Scotland. Energy is no exception, but Westminster retains the prime role in energy policy and its implementation by having set up a legal and regulatory framework. However, the devolution of power to Scotland in the energy sector encompasses essential aspects of the energy transition: renewable energy, fuel poverty and environmental regulation [114].

Context-wise, Brexit may have potential cascading effects that are difficult to predict for the regulation of the energy system in all of the UK, including for electricity storage development.

In the following subsections, we shall present the actors and policy goals related to electricity storage and EV smart charging. Subsequently, an overview of the national and local regulations impacting the development of the concerned technologies and services in the UK was provided, with a final focus on the Orkneys.

4.1.1 Actors and policy goals related to electricity storage and EVs

Aside from the fairly obvious law making and executive powers (at national and country level), other actors also have a role to play in the development of electricity storage (this being either stationary storage or *via* the use of EVs) in the UK.

The first actor is the Office of Gas and Electricity Markets (Ofgem), the independent national regulatory authority (NRA) in the UK. The main role of Ofgem is to orientate and control the application of the legal framework concerning electricity and gas, e.g. by setting the rules for awarding licences or by investigating alleged breaches of these licences [115]. As will become evident in the next subsection, Ofgem currently plays a particularly significant role in framing the development and operation of electricity storage facilities.

Another important actor is the network operator. Being part of the EU (at least until the 31 October 2019) and being a liberal state in favour of private initiative and free market, the UK adopted unbundling rules requiring network operators to be legally separated from generation or supply activities. For the transmission grid, there is only one TSO, namely National Grid Electricity

Transmission plc (NGET). NGET is in charge of the operation of the whole transmission grid [116]. However, the transmission grid has different owners depending on the area. In the northern part of Scotland, including the Orkneys, the owner is Scottish Hydro Electric Transmission plc, part of Scottish and Southern Electricity Networks (SSEN) [117]. It is also in charge of maintaining and developing the grid. For the distribution grid, there are fourteen licenses dividing the UK territory. These fourteen licenses correspond to fourteen distribution network operators (DNOS - DSOs are named DNOS in the UK and do not have exactly the same powers as DSOs), owned by six companies. The DNO for northern Scotland, including the Orkneys, is Scottish Hydro Electric Power Distribution plc, also part of SSEN [118]. Figure 5 below demonstrates the allocation of the licensed zones.

Electricity Distribution

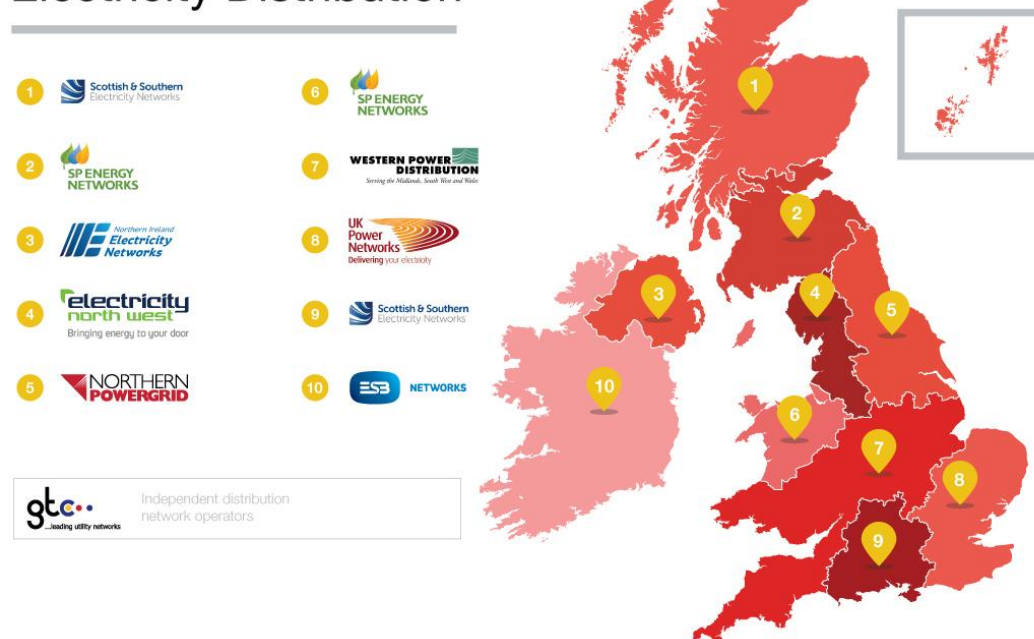


Figure 5 – Electricity distribution map (source: Energy networks association, [http://www.energynetworks.org/info/faqs/electricity-distribution-map.html] accessed 5 March 2019)

TSOs and DNOs are important actors for the development of electricity storage, as they might be interested in investing in these technologies to avoid grid extension or reinforcement. This is particularly the case on the Orkney islands, where the cable connection to the mainland is congested [119]. However, as we shall develop in the next subsection, the new regulation being implemented in the UK tends to prohibit network operators from owning and operating storage.

In addition to the elements brought up concerning the actors involved in electricity storage development, it is also meaningful to set the policy framework for this development.

In 2011, the then Department of Energy and Climate Change – since then reorganised and renamed as Department for Business, Energy and Industrial Strategy (BEIS) – issued a white paper “for secure, affordable and low-carbon electricity”[120]. This document does not provide quantified targets for the development of storage, but it mentions the topic multiple times as a key element for the future of networks and for system flexibility [121]. The BEIS announced that a new energy white paper will be published in 2019, probably with a stronger emphasis on storage [122].

At country level, the Scottish Government published an Electricity generation policy statement (EGPS) in 2013 in order to reach the “target of delivering the equivalent of at least 100% of gross electricity consumption from renewables by 2020” [123]. Part of the document is dedicated to the role of storage in attaining the 2020 target and beyond 2020, and it identifies some barriers to its development [124]. In its annex B, the document refers to a study showing that by 2020 and increasingly by 2030, the absence of storage in the Scottish system would lead to significant renewable energy production curtailments [125].

Concerning the development of EVs, without going into too much detail, there are quantified targets for EV development, backed by a planned ban on petrol and diesel car sales by 2032 in Scotland and by 2040 in the UK as a whole [126]. These developments will have to be accompanied by measures concerning the recharging infrastructure, where questions of ownership, operation and electricity supply are often similar to stationary electricity storage issues [127].

In the following subsection, we will detail how the aforementioned actors play a role in the development of a legal and regulatory framework for electricity storage in the UK, including through EV smart charging, and how the policy goals are being translated into law.

4.1.2 National legal and regulatory framework for electricity storage and EVs development

Electricity storage

In the UK, the main act setting the legal framework for the electricity system is the Electricity Act of 1989. It provides the rules for generation licensing, electricity supply and ownership unbundling requirements. However, this act does not refer to electricity storage. According to the Government, this legal loophole will remain until 2022, because of the lack of parliamentary time to modify the aforementioned text due to the Brexit overload [128].

As electricity storage is not defined nor qualified by law, the relevant actors (Ofgem, storage owners and operators) have regarded it as generation for the past decades [129]. This was not a widely debated issue when storage was only composed of PHS (four stations totalling 2.8 GW of capacity) [130]. Nonetheless, these facilities were submitted to double charges for balancing service costs (BSUoS) for a total of £14.9m in 2014-2015, which was “made up of £5.6m in charges applied to generation and £9.3m for consumption” [131]. For much smaller storage systems such as batteries, these double charges represent a strong barrier. Still, in a tender organised by National Grid (the TSO) for frequency response, over 550 MW of storage capacity (all with batteries) have been allocated since 2016 and are due to come online by 2020 [132].

Concerning storage ownership or operation, as storage is considered generation, TSOs and DNOs are in principle prohibited to undertake these kinds of activities. However, there is an exemption regime allowing TSOs and DNOs to own and operate a generation facility (and by extension a storage facility) without a licence for a capacity lower than 10 MW (the owner/operator does not have to request permission from the competent ministry) or up until 50 MW with a total net declared capacity of less than 100 MW (for which the owner/operator does have to request permission from the competent ministry) [133]. Another limit called *de minimis* adds up to this threshold for DNOs:

Non-distribution business activities, such as income generation from storage projects, are limited by de minimis restrictions specified in the distribution licence. These restrictions mean that turnover from and investment in non-distribution activities must not exceed 2.5% of DNO business revenue or licensee's share capital respectively [134].

Therefore, even though DNOs can theoretically, under the absence of storage regulation, own and operate small and medium-sized storage installations, this must remain a limited part of their activities.

However, in 2017, Ofgem decided to act without waiting for the Parliament and published two proposals: one to modify the generation licence in order to create a subset dedicated to electricity storage, and another to change the electricity distribution licence in order to clearly prohibit DNOs from operating storage [135]. These proposals were submitted for public consultation [136]. As a result, Ofgem issued its decision on changes to the electricity distribution licence on 20 December 2018. Since 1st April 2019, the new electricity distribution licence conditions apply, prohibiting DNOs (including independent DNOs – IDNOs)

from carrying out any generation activities, which include the operation of storage assets, unless the activity is captured by an exception or the licensee has been issued with a direction. The intention of these changes is to give effect to the operational unbundling of generating assets (including storage), enabling the competitive market for storage and other flexibility services.[137]

DNOs are therefore currently prohibited from operating storage facilities but not from owning them [138]. These new rules do not apply to TSOs, meaning they must still adhere to the former rules (with the 10 and 50 MW exemptions).

Among the exceptions mentioned in the new electricity distribution licence, there is an interesting point for the SMILE project concerning storage located on islands. This exception, however, is subject to other conditions in addition to the island's location, requiring the storage asset to be operated "solely for the purpose of ensuring security of supply of that island, and [that] those assets form part of a facility originally commissioned prior to this licence condition taking effect"[139]. As a result, it might be a useful exception for maintaining the reliability of the island's network (especially in the absence of an interconnection), as the term "security of supply" is relatively broad but cannot be overused by DNOs.

A decision to issue a definition of storage together with a new storage licence as a subset of the generation asset class is still pending. We therefore worked on the document submitted for public consultation in 2017. In this document, electricity storage is defined as:

The conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy [140].

This definition implicitly clarifies that storage constitutes a separate step in the electricity chain from generation to consumption, but it is not as broad and detailed as the 2019 Electricity Directive's definition and does not take into account the conversion of electricity to another form of energy to be later used in this other form (such as hydrogen, synthetic natural gas or heat) [141]. Consequently, there is a risk that this definition will have to change shortly after its adoption or that another set of rules will have to be adopted to clarify certain situations, such as P2G or P2H.

Concerning the issue of double charging, the proposal for a new generation licence introduces a new condition (E1) requiring the licensee not to “have self-consumption as the primary function when operating its storage facility”, in this case being exempted from final consumption levies [142]. The storage facilities would then only be submitted to generation levies. However, the reality is somewhat more complex, as is demonstrated by Ofgem’s “Open letter on implications of charging reform on electricity storage” from January 2019. In a nutshell, this guidance document explains that the current reform of the system and network charges for storage will have as a consequence the dispensation of these facilities from paying the consumption part of the Distribution Use of System (DUoS) and Transmission Network Use of System (TNUoS) charges in order for storage not to be “disadvantaged in relation to other types of generation through paying balancing service charges for both imported and exported electricity”[143]. If this move allows to address the double charging issue, time alone will tell if these changes are sufficient to create a level playing field for storage. Moreover, the situation seems to be solved when it comes to the Climate Change Levy (CCL), a levy placed on the electricity consumption by businesses. It is argued that storage is submitted to it twice [144], accounting for another instance of double charging detrimental to the development of electricity storage. In response, Ofgem and the Government argue that with the new licence for storage, “the electricity received and stored by electricity storage facilities may be supplied to them free from the Climate Change Levy, where relevant conditions are met”[145].

In addition to the above, we think that it would have been interesting to contemplate on the possibility of applying network charges for the electricity taken from the grid instead of the electricity injected into the grid in order to promote the storage installations using the most efficient technology in terms of conversion losses. Another option to incentivise even more the use of efficient storage technologies would be to consider completely relieving electricity storage from network charges as soon as they fulfil some requirements in terms of network support, or only taxing the electricity lost in the conversion process, applying the final consumption levies to this share.

Some observations are needed concerning the co-location of a storage facility at a renewable energy (RES) generation site, as this was a topic of concern for RES developers and it might apply to the Orkneys in the future. As argued by Ofgem and the Government in October 2018, Ofgem has published guidance for the installations benefiting from support schemes for renewables in the UK (RO/FiT/CfD) in order for them to gain legal certainty [146]. Depending on a number of conditions (such as notification to Ofgem), it should be possible to co-locate storage with RES generation without losing the benefits from the support scheme.

Finally, it should be noted that technical standards published by the Energy Networks Association are increasingly taking electricity storage into account, especially for connection to the grid procedures [147]. Nevertheless, these developments do not provide relevant elements for our analysis, perhaps apart from the statement in Engineering Recommendation G99, which states that “In GB law, Electricity Storage is treated just as generation”, confirming the aforementioned developments [148].

In conclusion, the recent progresses made by the UK NRA and the Government to define electricity storage and to clarify its regime constitute an important step towards enhanced legal certainty for the development of the related technologies. However, different approaches could have been taken on some aspects, and perhaps in the near future some changes will have to be made. Here, we are referring to the exclusion of P2X in the definition of storage, to the use of a subset of the generation licence for storage instead of creating an independent asset class with its own licence, and to the still incomplete relief from double charging [149].

EV smart charging (and in combination with small-sized in-house storage)

Multiple questions arise concerning the development of the infrastructure to smart charge EVs and thus helping to avoid grid congestion and curtailment of the generation from renewable energy sources by using the battery in the EV. These questions, for example concerning who can own and operate the charging station and about the rules concerning the electricity provided to the EV, will be answered in the next paragraphs.

The Automated and Electric Vehicles Act, adopted in 2018, has brought expected elements of legislation concerning EVs. Firstly, it provides a rather straightforward definition of a charge point in its article 9 (1) (a): “A device intended for charging a vehicle that is capable of being propelled by electrical power derived from a storage battery (or for discharging electricity stored in such a vehicle).” Therefore, the term charge point is used for EVs only, as hydrogen vehicles have their own “hydrogen refuelling point” as defined in article 9 (1) (b). It is also important to note that charge points can be used both for charging and discharging an EV, paving the way for vehicle-to-grid uses (V2G - not tested in the SMILE project) and reinforcing the possibility to use EVs as an electricity storage technology.

Secondly, the act actually does not impose anything, but it provides various avenues for the Secretary of Transport to adopt regulations. In this way, future regulations “may impose requirements on operators of public charging” concerning the method of payment, the availability of the public charge point, or its connecting components (such as the socket model) [150]. These regulations may also impose on “large fuel retailers or service area operators” to provide public charge points [151], they might transfer this regulatory power to the mayor for the area he has oversight of, [152] or they may require public charge point operators to make information available about a point, for example about its location, its charging options, the cost to use it, the methods of payment, etc. [153]. At the end of the day, all of these potential regulations, still unpublished to date, will offer a better regulatory framework for the development of EVs in the UK, although many questions remain [154]. However, as far as the SMILE project is concerned, all these provisions will be of limited use. Indeed, the EV charge points “smartened” in the Orkneys are installed either in private EV owners’ houses or in tourist businesses but limited to use by their clients [155]. Hence, the scope in the Orkneys is limited to private charge points. Fortunately, article 15 of the Automated and Electric Vehicles Act concerns all charging points, including private ones [156]. This provision allows future regulations to impose that any charge point sold or installed is actually a smart one. This includes the capacity to receive and send information, to be accessed remotely, to monitor energy consumption, etc. In other words, charging points may have to be controllable from a distance and to authorise charging when excess power is available, just as in the Orkneys for the SMILE project. Additionally, from 1 July 2019, the attribution of a government support for the installation of a charging point at home (Electric Vehicle Homecharge Scheme) will be conditioned to its smart character [157].

It must be noted that the legal qualification of an EV charge point operator (the question whether it is an electricity supplier or solely a service provider) is not entirely clear under the current regulations [158]. However, when it comes to the SMILE project set up in the Orkneys concerning EV charge points, this question does not matter, as these points are not open to an indiscriminate public, as stated above. Therefore, there are two options: either the business’ owners simply sell the electricity to charge EVs as part of the total service (room rental, etc.), which is also the sense of the interpretation of EU directive 2014/94/EU, article 4, paragraph 8 for public charging stations as seen earlier in this report (the service provider interpretation) [159], or the business owners decide to present a separate bill to EV users for the electricity they consumed for charging their car. In the second case, business owners would likely become electricity suppliers and would need a licence, which they certainly do not want to. The first option is therefore the most likely to be applied, meaning that the tourist business

owners will integrate the costs of the EV charging into the total price of the service they sell (room, restaurant, etc.).

Another issue that could possibly arise is when various smart charging stations and small-sized in-house battery systems are linked together and piloted by an aggregator providing demand response services to the grid operators. In the Orkneys, this question already seems present for OVO-Energy and RouteMonkey, as they own and operate various small-sized in-house batteries or various EV charging stations to create load-following systems depending on the wind energy production on the islands. Ofgem is aware of the importance of aggregators in the energy system and is looking to lift some barriers to demand response aggregation [160]. It is important to follow the evolution of the regulations of these actors in the coming years, as they might have a decisive role for smart grid solutions on islands.

4.1.3 Local regulatory framework for electricity storage and EVs development

As the Scottish Government admits, “Energy policy is largely reserved to UK Government”[161]. Even if the Electricity Act of 1989 leaves some powers to Scottish ministers to adopt energy-related regulations [162] or to take decisions on energy-related applications (for the construction and operation of onshore electricity facilities generating over 50 MW for example),[163] those ministers cannot adopt a whole new legal and regulatory framework for electricity storage or EV charging stations. However, it must be stated that the Scottish Government published its “Scottish Energy Strategy” in December 2017, which mentions electricity storage many times and in which the Government claims that “storage is a strategically important issue, with real potential benefits for Scotland”[164].

In order to look for specific local regulations applying to the Orkneys, we searched for regulations proper to islands applicable in Scotland. In its article 1, the Islands (Scotland) Act 2018 provides an interesting definition of islands [165], but the act does not mention the word “energy” at all and only once refers to electricity, but this is not related to an issue that is relevant here.

It appears from the above that as the Orkneys are connected to mainland Scotland, as their grid is operated by SSEN, the DNO for Northern Scotland, and as they apply the same general rules concerning both electricity storage and EV charging points as the rest of the UK, there are no particular local regulations to look for.

4.2 Samsø - Denmark

Denmark is a constitutional monarchy. Its Parliament (*Folketinget*) can “delegate its law-making competence to the administration”[166]. While the central government is the main executive power, the municipalities (local governments) play a significant role in a number of geographically restricted areas. Energy supply is among the tasks largely executed by municipalities in Denmark [167].

In the subsections below, we will discuss the actors and policy goals related to energy storage and EVs in Denmark and on the island of Samsø. Subsequently, we will study the national legal and regulatory framework for these technologies, before turning to the specific framework on Samsø.

4.2.1 Actors and policy goals related to electricity storage and EVs

Aside from the Danish Parliament and Government, whose actions we will analyse in the next subsection, we will first present two important actors (or groups of actors) for the Danish electricity system: the NRA and the grid operators. After that, we shall focus on the Danish energy policy and its consideration for storage (stationary or through EVs).

From 2000 to 2018, the Danish NRA was named Danish Energy Regulatory Authority (DERA). Its role at the time was as follows:

The regulator fulfils the special sector-specific supervisory and complaints function in relation to the energy sector. Among the main tasks are the regulation of the prices and terms of supply fixed by the monopoly companies – including the terms applying to access to the networks [168].

The regulator's name changed since the 1st of July 2018 and is now known as the Danish Utility Regulator (*Forsyningstilsynet*) [169]. "All tasks carried out by DERA has [sic] been transferred to the Danish Utility Regulator"[170]. Its area of competence is large and may encompass electricity storage issues, as the authority must ensure a "cost-effective green transition"[171]. However, when looking for "electricity storage" (*ellagring*) or "energy storage" (*energilagring*) on the searching device of the authority's website, we did not get any results.

For the Danish energy transition, the role of electricity networks operators is crucial. Indeed, given the high level of wind energy in its mix, the Danish grid and the interconnections with its neighbours (Sweden, Norway and Germany) is of vital importance. In Denmark, the (electricity and gas) TSO is strictly unbundled from generation and supply, as stated by the law [172]. Energinet is an independent public company owned by the state, and its main responsibilities are "system operation, effective operation, and development of the overall infrastructure, and ensuring open and equal access for all users of the grid and security of supplies at all times." It also has a planning responsibility for the evolution of the energy system [173].

At the distribution level, the "grid is owned and operated by approximately 57 local electricity distribution companies. These are usually owned and controlled by municipalities or organised end-users within the respective grid supply area"[174]. The unbundling rules for DSOs are more relaxed than those for the Danish TSO, and a DSO can be owned by an energy generator and supplier, which is also the case for Samsø, where the DSO is Konstant, owned by NRGi [175]. However, in accordance with European law, DSOs in Denmark have certain obligations, such as non-discriminatory third party access [176].

Denmark is one of the forerunning countries in the EU when it comes to the share of renewable energy in its energy consumption and especially in its electricity mix [177]. Wind power alone produced close to 44% of the electricity consumed in the country in 2017 [178]. For the future, the Danish Government has set a target of 100% of its electricity coming from renewable energy sources by 2030 and a target of 100% of its energy being consumed from these sources as well by 2050 [179]. However, the integration of a high level of variable renewable energy into the electricity mix exposes the Danish grid to a high risk of malfunction if no adequate measures are taken. To face this risk, Energinet produced an interesting graph in its Strategy Plan 2010, displayed in figure 6.

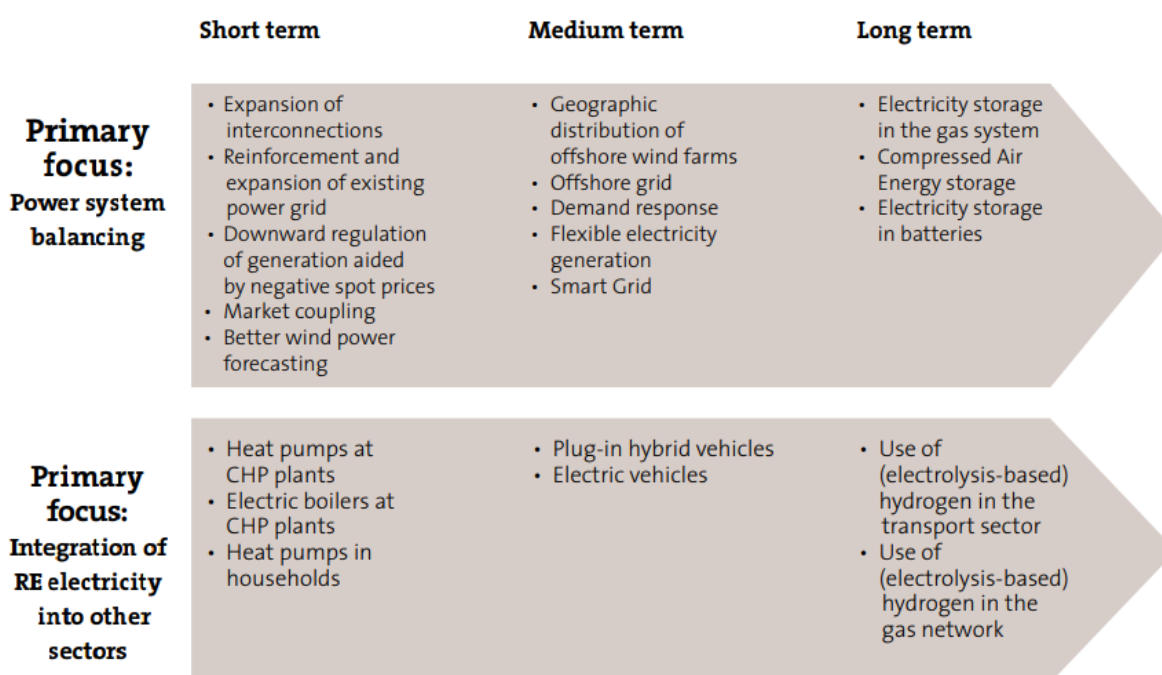


Figure 2 Means of integrating wind power.

Figure 6 – Means of integrating wind power in the Danish electricity network (source: Energinet, Strategy Plan 2010, 2011, p. 15, fig. 2 [file:///X:/My%20Downloads/Strategy%20plan%202010.pdf]).

This figure shows that to integrate high levels of wind power, the TSO perceives that the first measure to be taken in the short term is the expansion of interconnectors and that the last long-term measure should be to install electricity storage by batteries.

This approach on interconnections and electricity storage does not only appear in Energinet's documents, but in various other policy documents issued by the Government or influencing its policy. Indeed, in the Danish Energy Agency's Energy Strategy 2050 [180] and in the Government's *Energistrategi* 2050 [181] it is clearly stated that hydropower pumping stations located abroad (in Norway and Sweden) are a cheaper solution for electricity storage than PHS in Denmark (which does not benefit from hydropower resources [182]) or the use of electricity batteries. What is more, the IDA's (Danish Society of Engineers) Energy Vision 2050 document only mentions "electricity storage" twice. First, it refers to power-to-gas and power-to-liquids and clearly foresees an energy system interconnecting different energy carriers:

By using electrolyzers as a mediator for electricity storage by converting the intermittent electricity from renewable sources to the gases or liquids that can be used in energy sectors or stored in different storage technologies, we establish the interconnection between electricity, gas and transport sectors. These technologies therefore offer a solution for meeting different fuel demands while providing flexibility to the system. In this way, we compensate for the lost flexibility on the resource side by providing flexibility in the conversion processes. As the fuel production facilities produce excess heat, this is another important factor for the integration of fuel production and heating sector in the future [183].

Then, it is made clear that "100% renewable energy is achieved without batteries or electricity storage if the purpose is to put electricity back into the grid." The aim is to avoid "high costs and round-trip losses"[184]. In contrast, thermal storage is an essential piece of this energy vision, and it appears many times in the document [185]. Based on these documents, it seems that there is not much to

expect from the Danish legislation in terms of electricity storage, as it has not yet been developed on a large-scale and it is not intended to.

In contrast, energy policy documents display a certain interest in EVs as part of the flexibility mechanisms for the integration of a higher share of renewable energy sources into the energy mix (including but not limited to electricity). This appears in the graph displayed in figure 6 as a medium-term measure. EVs are considered a flexible electricity demand by IDA's Energy Vision 2050 where "in the 2050 scenario, battery electric vehicles meet 75% of the private car transport demand and the rest is met by electrofuels" and EVs are even qualified as short-term storage and flexibility instruments in the envisioned Smart Energy System [186]. This vision of EVs and their services to the grid is shared by Denmark's Draft Integrated National Energy and Climate Plan of December 2018, in which the Government announced a target of "more than 1 million green cars" by 2030. Reaching this target is supposed to provide among other technologies "a basis for increasing flexibility through increased demand response and energy storages"[187]. Additionally, the Danish Ministry of Energy, Utilities and Climate also announced a ban on the sale of new petrol and diesel cars by 2030 and of plug-in hybrid cars by 2035 [188]. In conclusion, EVs are seen as a source of flexibility for the electricity system and their development is incentivised in Denmark. Therefore, we can expect sizeable legislation on this aspect of the energy transition.

Since 1997, the Danish Government considers Samsø as "Denmark's renewable energy island"[189], or in other words, as a "test environment for green solutions"[190]. In the island's main energy policy document, called Samsø Energy Vision 2030, in which the aim is to reach 100% of renewable energy use by 2030, electricity storage is barely mentioned. The most relevant reference to this option runs as follows:

Electricity storage is ~100 times more expensive than thermal storage, while thermal storage is ~100 times more expensive than gas and liquid storage. Therefore, where possible, it is important to connect wind and solar to these cheaper forms of storage energy (i.e. thermal, gas, and liquid) rather than the much more expensive electricity storage [191].

Consequently, there are no prospects for development of electricity storage especially by batteries on Samsø. If a battery has indeed been installed in the marina for the SMILE project, this is mostly due to the specificity of its location, within a local grid behind the meter to the public grid. Therefore, not many local regulations for electricity storage on Samsø are expected to be found, except technical instructions for power quality.

The assessment for EVs is different, as they are to become the norm for the transportation on Samsø by 2030. The different scenarios presented in the policy document are all based on 100% EVs for cars and vans alongside a mix of different fuels (electricity, biofuel, biogas, etc.) for public transportation including ferries [192]. The reason for this choice of an all-EV set-up is to absorb the "abundance of wind power resources" on the island and for the EV's high efficiency [193]. EVs are therefore clearly seen as a flexibility provider to deal with a high share of electricity from variable renewable energy sources, especially the wind. This view also appears in the Action Plan for a Fossil Free Island released by the municipality of Samsø. This document explains that the municipality already partially switched to EVs for its vehicles but that there are still challenges that must be met in order to reach the 2030 fossil free objective: the transition to EVs outside the public sector depending on a private decision, the capacity of the electricity system, and the flexibility of EV charging (smart charging) in order to use excess electricity [194]. Locally, these developments might trigger some interesting regulatory developments.

In the following subsection, we will present the national legal and regulatory framework applicable to electricity storage and to EV development in Denmark.

4.2.2 National legal and regulatory framework for electricity storage and EVs development

Electricity storage

The main act organising the electricity market in Denmark is the Electricity Supply Act (ESA) or *Elforsyningsloven*. The first version of this act was adopted in 1976, after which it was reformed in 1999 and recently again in 2018 (and it was amended in early 2019) [195]. We will not go into too much detail of the ESA *per se*, as it follows the principles of the EU directive on the internal electricity market. The main finding from the analysis of this act is that “storage” is not mentioned. It does not appear in article 2, where it is stated that “the Act applies to the production, transport, trade and supply of electricity”[196], nor does it appear in the definitions under article 5 or elsewhere in the text. The same is true for the latest version of the Promotion of Renewable Energy Act (PREA) or *lov om fremme af vedvarende energy* [197].

Since electricity storage does not enjoy the benefit of a regime, we can only make some assumptions. Like in the UK (and many other EU countries [198]), storage might be regarded as generation in the absence of rules. In this case, unbundling rules clearly apply, and these would prohibit the ownership and operation of a storage facility by the TSO, Energinet. For the DSOs, as seen earlier in this section, the separation is not so strong, and one can imagine a company owning storage and owning distribution grids, but these would have to be in two different entities to avoid discriminatory behaviours towards other grid users [199]. If storage is regarded as generation, then a licence is not needed if the installation has a capacity of up to 25 MW, leaving room for small, medium and some large-scale electricity storage installation development with a reduced administrative burden [200]. The currently unclear situation regarding electricity storage in Denmark lead the authors of another EU-funded project’s deliverable to recommend a change of the legal framework, especially concerning double payments. They argue that “since energy storages are merely storing the energy they should be relieved from most of the Public Service Obligation as well as added electricity tax”[201]. In detail, they recommend that these fees (the Public Service Obligation) and taxes (electricity tax) only be applied at the final consumption point [202]. On this issue, the UK case seen in the previous section provides an interesting example of a situation in which double payment is currently being addressed. Similarly, a potential solution could be that grid tariffs and taxes either concern only the electricity consumed (and not the electricity injected into the grid) or even to be imposed solely on the lost electricity during the storing process. In case of the latter, it would suffice to calculate the amount of electricity entering the electricity storage asset and the amount being released from it. The part not returned to the grid would then be considered as final consumption, in which case the fees and taxes would fully apply, while fewer or ideally no such fees and taxes at all would be paid for the part reinjected into the grid. As presented in the policy section, electricity storage is clearly not a priority in Denmark, but having a clear legal framework would help using it when it is the best option (for example to support a congested part of the network).

Although Denmark has no provisions in place regarding electricity storage, there is a technical standard on batteries. The main interest of this document lies in the part where it defines battery systems. According to this standard, “a battery installation is a system that can store and deliver electrical energy” in four different ways. 1) It can take the electricity from the “collective electricity supply network” and later on deliver it back to the grid or 2) deliver it internally to the installation it is part of,

or 3) it can take the electricity from an installation instead of the grid and later deliver it back to the same installation or 4) to the public grid [203]. The standard is therefore limited to electricity-to-electricity storage and does not include energy conversion. The SMILE project on Samsø, with a battery installed behind the meter to the public grid, corresponds to the third case in this definition: from an installation and back again without using the “collective electricity supply network”[204]. It should be noted that the definition also states that a battery system can be “permanently and temporarily connected” to the grid or the installation and that this includes “V2G” or Vehicle-to-Grid, henceforth considering EVs as a storage technology. As this definition is limited in scope, it would be more appropriate to transpose the version in the 2019 Electricity Directive instead of using this one.

EV and boat smart charging

In Denmark, the development of EVs is seen as a measure to increase the flexibility of electricity consumption and to absorb excess generation from renewable energy sources when needed. That is why the so-called Registration Tax Act contains a provision offering a discount on the registration tax EV owners are required to pay when buying their car. This discount existed for some years already, but it had been phased out and reestablished, and now it shall be gradually phased out again by 2023 [205]. However, the legal framework for EV (smart) charging stations seems incomplete at best. Indeed, the supposedly key Alternative Fuel Infrastructure Act does nothing apart from delegating the role of adopting a framework for such an infrastructure to the Minister of Transport, Building and Housing [206]. Therefore, it is more appropriate to refer to the 2018 Executive Order on requirements for technical specifications for publicly available infrastructure for alternative propellants and its amendments. The value of this text for our research is contained in art. 2 concerning the definitions. In this article, EVs are defined as:

A motor vehicle equipped with a power unit that contains at least one non-peripheral electric machine as an energy converter with an electrically rechargeable energy storage system that can be recharged externally [207].

A charging point is defined as:

An interface capable of charging at least one electric vehicle at a time or replacing a battery for at least one electric vehicle at a time. The electric vehicle charging interface can consist of multiple sockets or vehicle couplers, enabling multi-standard charging [208].

Finally, the article defines a publicly available charging point as:

A charging station [...] for supplying an alternative fuel that provides non-discriminatory access for users. Non-discriminatory access may include different terms of approval, use and payment [209].

This last definition is the most helpful for us, as it specifies that the publicly available charging point supplies the alternative fuel (such as electricity [210]) on a non-discriminatory basis. This means that all EV users can access the charging point, even if they do not have a contract with the operator of the point or with a specific electricity supplier. Still, this non-discriminatory access is flexibly interpreted, as it can “include different terms of approval, use and payment.” This last sentence is quite unclear, unfortunately.

Some additional elements have been added to the act later in the same year, providing some more clarity. Since mid-2018, it has been specified that:

All publicly available charging stations shall also allow users of electric vehicles to be charged on an ad hoc basis without having to enter into a contract with the electricity supplier or operator concerned [211].

Additionally, it is stated that:

On all publicly available charging stations, the price of charging must be stated in a clear and visible manner [212].

Consequently, the user's choice is reinforced, because they are not forced to enter into a contract with the operator of the charging point or with a specific electricity supplier, and prices have to be clearly provided beforehand. The legislation currently in place seems therefore to follow the logic of the EU regime on EVs on this point [213].

Before reaching a conclusion on the national legislation for EVs, a point has to be made concerning boats, because they are included in Samsø's demonstrator. First of all, according to Danish law, boats are not vehicles, as they are not meant to use roads [214]. Therefore, they cannot be regarded as a type of EV. However, the 2018 Executive Order gives the following definition for shore-to-vessel power supply: "shore-to-sea or shore-to-sea-going vessel power supply through a standard interface"[215]. Unfortunately, the term is only used in annex 1 of the order to indicate that such installations have to comply with the Standard for utility connections in port dating back to 2012, which was withdrawn and replaced by a new one in the meantime [216]. It should be noted that this new standard does not apply to low-voltage shore connection systems and therefore does not seem to be applicable in Ballen's case. Consequently, it seems necessary to apply an ad hoc regime to the boats connected to the Ballen marina's electricity cable, one based on the regime for EV public charging stations.

From a conversation with a member of the Danish Energy Ministry (the DEA/Danish Energy Agency), it appears that the electricity network of the Ballen marina could be considered as an "internal grid", which is a non-existent qualification in Danish law but accepted in various case laws. An internal grid usually corresponds to a building or a group of buildings only connected to the public network by a single meter. Behind this meter, one can find (small-sized) production or storage and the grid itself which conveys the electricity to the different users. This qualification would allow to place a name on the legal grey situation formed by Ballen marina's cable, especially as there is no CDS in Danish law and as the conditions for a direct line in Danish law render its application impossible in this case [217]. It should be noted that the notion of CDS is supposed to be integrated into Danish law when the Parliament will update the Electricity Supply Act to transpose the CEP, but also that as seen earlier in section 2.3.4, in the current situation, the Ballen "internal grid" cannot be considered as a CDS. The direct consequence of considering the marina's cable as an internal grid is that the electricity which is produced, stored and consumed behind the meter to the public grid is in principle not taxed. This was expected by Samsø's municipality in order to recoup their investment more easily (although this was financed with an EU funding) and to foster replicability. In addition, we can here pursue the reasoning presented in previous sections 2.3.4 and 3.2.2, and consider the municipality as the final electricity customer behind the meter, as it consumes it for its own harbour buildings and, for the main part, provides it to the boat owners inside of a service package including the rental of the harbour spot. In the SMILE project plan for Samsø, it is intended to soon smarten the sockets to which the boats are connected, so that their consumption can be measured individually and demand-side management can be used to help maintain the grid [218]. This might imply to actually bill the boat owners specifically for the electricity they use. In this case, the municipality could be considered as an electricity supplier, meaning it would need a licence and boat owners would be entitled to the freedom of choice of

suppliers [219]. It is therefore recommended to find another way for the municipality to incentivise boat owners to flexibilise their consumption than by addressing them electricity bills. Perhaps, a different parking price for boats accepting a flexible use of their battery in contrast with those who would reject it could be an option to investigate further.

Finally, in all the legislation studied for EVs (and boats), no mention is made of smart charging. Here as well, the UK example could be an interesting source for deploying charging points which can help provide this sought-after flexibility.

After this overview of the national legal framework applying in Denmark concerning electricity storage, EV deployment and charging and even the electricity supply to boats, it is necessary to analyse the framework specifically applicable to Samsø island and the Ballen marina. This will be discussed in the following section.

4.2.3 Local regulatory framework for electricity storage and EV development

As an introduction to this subsection, it must be stated that we did not find any piece of regulation proper to the local level on Samsø, either at island or municipality level (covering the same area) or at the level of Ballen and its marina. Therefore, the following developments consist of a construction based on the few elements gathered specifically through the SMILE deliverables and from the local partners' answers.

Concerning the Ballen marina's electricity network, the local partners state that the grid pertains to the municipality and that the municipality also operates it and provides electricity to the consumers connected to it. When we refer to "the municipality", we could usually expect to find a limited liability company fully or partially owned by the municipality, which is the main way for municipalities to take action in the electricity system according to the legislation [220]. However, in the Ballen marina's case, the local partners specified that the PV plant and the battery are directly owned and operated by the municipality itself, without using a special purpose vehicle. It seems that the municipality obtained an exemption from this usual rule, due to the small size of the production and storage facility (the PV plant has a capacity of 60 kW and the battery can store up to 240 kWh). This makes the municipality a sort of small-sized vertically integrated undertaking behind the marina's meter.

Regarding EV charging, this is out of the scope of the SMILE project on Samsø, but it seems interesting to mention that in 2017, there were four charging stations on the island all owned and operated by the municipality, where the electricity is supplied by NRGi (which also owns the DSO acting on Samsø). The Samsø municipality first offered free electricity from their public chargers, but now EV owners must pay – not under a contract, but per single charging session – in order not to discriminate fossil fuel cars. Finally, while EVs are not part of the project, boats are but no specific local regulation for EV or boat charging seems to exist according to our research.

4.3 Madeira – Portugal

Portugal is a centralised state with two autonomous regions: Madeira and the Azores [221]. In the case of Madeira, the local Parliament and Executive have more autonomy than mainland regions: they can adopt acts and benefit from a larger budget. However, the central government in Lisbon still has the last word as it ratifies the regional assembly's acts [222]. Concerning the legal and regulatory

framework applicable to smart grid technologies in Madeira, it is therefore necessary to analyse both the national and the local measures adopted.

In the following subsections, we will present the actors and policy goals at the national and island levels for electricity storage and EV development. Subsequently, we will study the national and local legal and regulatory framework for the development of these smart grid technologies.

4.3.1 Actors and policy goals related to electricity storage and EVs

Although the national Parliament (Assembly of the Republic, located in Lisbon) deals with energy, it appears that the energy sector in Portugal is mostly regulated by decree-laws and other regulatory instruments, with only a few legislative acts [223]. Concerning Madeira's legislative assembly, the analysis of its permanent special commissions shows that none deals with energy, in contrast to topics such as transportation, agriculture, tourism or health [224]. When the Assembly elaborates a text concerning energy, in many cases it will send a draft of act to the national Parliament in Lisbon instead of adopting it on its own, reinforcing the image of a local Assembly without a significant role concerning energy [225].

Aside from the legislative bodies, the main actor in terms of regulation of the energy system in Portugal is the NRA: ERSE - *Entidade Reguladora dos Serviços Energéticos* (Energy Services Regulatory Authority). The ERSE regulates both the electricity and natural gas sectors and aims to ensure, among other tasks, a fair competition on these energy source markets [226]. Its authority covers all of Portugal, including Madeira.

Concerning the grid operators, the case of Madeira is special, as it benefits from an exemption from liberalised market rules due to its isolated location [227]. As a consequence, EEM is not only the TSO and DSO on the island, but also the main generator and the supplier there. This means that in principle, EEM can own and operate electricity storage, even if it is considered generation. Similarly, it will probably have a role to play in the development of EVs, and more specifically for the deployment of the charging infrastructure.

In addition to the actors that will have to deal with the development of electricity storage and EVs, it is important to look for the policy goals on these topics.

In 2013, the Portuguese Government approved the *Plano Nacional de Ação para as Energias Renováveis para o período 2013-2020*, or National action plan for renewable energies 2013-2020 (PNAER 2020). In this document, the Government commits to reaching a level of renewable energy of 31% in final energy consumption by 2020, translated into a target of 60% of electricity from renewable energy sources [228]. In order to support this development, which is mainly driven by wind energy, Portugal places a focus on the development of hydroelectricity and, when possible, pumping stations [229]. Electricity storage is not mentioned in this plan. However, an auction has been announced for 2019 for "dispatchable renewable energy", which could include different kinds of renewable energy sources coupled to different kinds of storage technologies (batteries, P2G, etc.) [230]. Additionally, electromobility (e-mobility) is a topic of interest for energy source diversification in Portugal, and the country has implemented a voluntary program for the development of a network of EV charging stations named Mobi.E, on which we will provide more information in the subsection below [231].

The main energy policy document currently in force on Madeira is the *Plano de Acção para a Energia Sustentável*, or Action plan for sustainable energy, adopted in March 2012. According to this

document, Madeira has the objective to reach 20% of renewable energy in its primary energy consumption and 50% of renewable energy sources in its electricity generation by 2020 [232]. To do so on a non-connected island, it is necessary to either base generation on dispatchable renewable energy (such as biomass or storage hydropower) or, if these types of energy sources are not available, to back up variable renewable energy sources (such as wind and solar) with storage. The latter option has been preferred in Madeira with a high development target for pumped-storage hydropower to support wind and solar energies growth [233]. This is not a new technique on the island, and some works have already started to increase the storage capacity [234]. Another local policy document, on adaptation to climate change, also mentions a necessary increase of the storage capacity of the island in order to allow the integration of a higher share of wind energy in the electricity mix [235]. Aside from the strong focus of the action plan for sustainable energy on PHS, it also mentions EVs. However, these are mentioned without a specific target, as the document only emphasises on the willingness to introduce more of them [236]. In a nutshell, electricity storage is perceived as a necessity on Madeira to be able to take full advantage of its wind (and solar) energy potential, but storage is mainly considered by means of pumped hydro.

In the following subsection, we shall present the national legal and regulatory framework for electricity storage and EV development in Portugal.

4.3.2 National legal and regulatory framework for electricity storage and EV development

Electricity storage

Portugal, as a member of the EU, has transposed the directives related to the liberalisation of the electricity market [237]. Its main act setting the legal framework for the electricity system is the Decree-Law n.º 29/2006. This act clearly states that electricity generation is a free activity (art. 17), that the activities of transportation are separated legally but also in terms of ownership from generation, distribution and supply activities (art. 25) and that distribution activities are legally separated from the activities not related to it (art. 36). According to art. 66 of this act, the national regime of liberalised electricity (including unbundling rules) does not apply to autonomous regions (including Madeira). However, art. 67 confirms that the competence of the ERSE extends to these regions. Finally, the entire act does not mention storage once.

Portugal has no legal framework concerning electricity storage. This is asserted by various sources, including another Horizon 2020 project's outcome [238]. This fact can also be confirmed, if need be, by a search on ERSE's website with the keyword *armazenamento*/storage, which only gives results concerning natural gas storage [239].

EV smart charging

Although no legal regime for electricity storage exists at national level in Portugal, there is a sizable legal and regulatory body concerning EVs. In fact, Portugal has been a leading country in the EU in implementing a programme of development for e-mobility since 2008 and in establishing its first comprehensive legal framework in 2010 with the Decree-Law 39/2010. Since then, this text was amended in 2012 and 2014 and complemented by numerous regulations [240]. As of today, the main elements of this legal framework concern the essential actors of e-mobility and the principles under which this system works.

The essential actors of the e-mobility system are presented in art. 5 of the aforementioned Decree-Law; they are the electricity supplier, the charging point operator, and the e-mobility network operator. Both supplying electricity and operating charging points are free activities, open to competition. The former need to be registered as suppliers (a status that conveys administrative complexities and important responsibilities) and the latter must apply for a 10-year licence. One single actor can be both a supplier of electricity for e-mobility and a charging point operator. The third actor, the e-mobility network operator, corresponds to a regulated activity. This manager of the energy and financial fluxes linked to the operation of the e-mobility network is appointed by the Government, and has to be unbundled from the charging point operators [241].

Additionally, the Portuguese legal framework also sets forth the main principles of the e-mobility system in article 4 of the Decree-Law. According to this provision, EV users enjoy freedom of access to any publicly accessible charging point independently of the electricity supplier they have a contract with, without having to enter into a new contract with the charging point operator, and the charging points have to be interoperable for different types of EVs. Interestingly enough, it is also stated in this article that EV users enjoy the freedom of choice of an electricity supplier at the charging point for e-mobility. The question of the interpretation of this provision remains the same as in the Orkneys and Samsø but it seems that in Portugal there is a lack of clarity on the application of EU legislation as EV users should not be considered final customers as explained in subsection 3.2.2. These principles are summarised in the principles of universal and equitable access to services.[242] In sum, the legal regime for e-mobility and EV charging in Portugal is the most accomplished out of the SMILE countries and can serve as a model, although it is not perfect. In this case, one can only regret the absence of provisions on the smart character of the charging operations, at the difference of the new UK regulations.

Lastly, the Portuguese legal framework for e-mobility acknowledges a parallel and different development in the autonomous regions, including Madeira. It is on this specific case that we will now focus our analysis.

4.3.3 Local regulatory framework for electricity storage and EV development

No piece of local legislation or regulation concerning electricity storage applies in Madeira. In any case, the question of electricity storage asset ownership and operation is not relevant, because in Madeira, EEM is the vertically integrated utility [243]. Logically, EEM is in charge of developing and operating storage, as it is currently doing within the SMILE project.[244] nonetheless, small-scale batteries are being installed in some houses or small businesses in order to foster self-consumption and to avoid any inconvenience for the grid, as electricity injection has been forbidden for small producers since 2014 [245]. Also, EEM is currently drafting a new grid code which will take into account electricity storage, in order to force the new small-scale renewable installations to respect certain grid parameters in order to maintain its balance.

Concerning e-mobility, a regional legislative decree was adopted in 2017 [246] on the adaptation to the autonomous region of Madeira of the Decree-Law 90/2014, as already mentioned above. Two elements of this text must be raised. Firstly, article 2 states that the *Direção-Geral de Energia e Geologia* (DGEG), or as Directorate-General for Energy and Geology, is replaced in its tasks in Madeira by the *Direção Regional da Economia e Transportes* (DRET) or Regional Directorate for the Economy and Transportation. As a consequence, it is the DRET that awards the 10-year licences to charging point operators on Madeira [247]. Secondly, article 3 of the 2017 Decree provides that the e-mobility

network operator in Madeira is Mobi.E S.A., a national Portuguese entity that has the same role on mainland Portugal [248].

In conclusion, it seems that the activity of charging point operator in Madeira is open to competition, which is confirmed by the fact that there are developments from private parties on the island concerning the installation and operation of charging points [249]. However, nothing is specified concerning the electricity supply, which leads us to conclude that the only electricity supplier in Madeira will remain EEM, which includes providing electricity for e-mobility in public charging stations.

4.4 Summary

In the second half of this deliverable, the legal and regulatory framework for electricity storage has been analysed (with a focus on the technologies deployed: batteries and EVs). As it appears in Annex 3, in general, electricity storage is not legally defined in most EU countries with islands, apart from a handful of Member States which have started to develop a storage regime (France, Italy and Greece) but these may need to be amended following the 2019 Electricity Directive. In this deliverable, we have more specifically analysed the legal regimes in the UK, in Denmark and in Portugal. We note that the UK has an advanced regulatory regime in place for electricity storage while Portugal has more experience on EVs deployment. By contrast, when considering the local storage and EV (smart) charging regimes on the three islands: the Orkneys, Samsø and Madeira, it appears that apart from Madeira there are no relevant local rules.

- The Orkneys, United Kingdom.

The UK is the only one of the SMILE countries to have a regulatory framework concerning electricity storage. This new regime provides a satisfying definition (although not as developed as the one in the 2019 Electricity directive) as it regards storage as a commercial activity open to competition and restricted for network operators, and starts to act on double charging (even though the solution to impose generation levies only can be discussed).

Concerning EVs and the charging stations, a legal and regulatory framework is under construction but still lacks clarity on the exact role expected from the different actors involved (especially between charging point operator and electricity supplier). The most interesting part of these new provisions is the clear interest for soon deploying smart charging points only. This last development should greatly help using EV charging as a demand-response and storage option.

No specific rules are implemented on the Orkneys concerning electricity storage and EVs.

- Samsø, Denmark.

In Denmark, there is no legal nor regulatory framework for electricity storage. This can be explained by the lack of interest for “hard core” electricity storage by batteries, which is deemed too expensive in comparison with the other ways available for balancing the grid. However, the adoption of a simple but efficient framework on electricity storage when transposing the CEP would be a good option for some cases, such as supporting congested grid sections.

For EVs, the legal regime is more developed as it provides definitions and provisions which seem to follow the logic of the 2014 EU directive on alternative fuels.

Concerning Samsø itself, the research undertaken allowed to qualify the Ballen marina’s grid as an “internal grid” with a high degree of certainty. However, this qualification highlights the lack of legal existence of this concept (apart from case laws) and also the lack of transposition by Denmark of the

closed distribution system (in EU law since the 2009 Electricity Directive) in its internal legislation. These should be solved as soon as possible to provide more clarity for geographically and purpose-limited networks. The plan of the municipality to smarten the charging of the marina's boats also raises interesting questions and pushes for regarding the harbour charging infrastructure as a kind of EV charging station.

- Madeira, Portugal.

In Portugal, there is no legal framework for electricity storage, just like in Denmark. However, the legal framework for EVs and their charging is one of the most developed in Europe. The legislation clearly establishes the role of the different actors in the charging operation (electricity supplier, charging point operator and e-mobility network operator) and considers electricity charging for EVs as a commercial activity (with the e-mobility network operator as a regulated activity). Some clarification would however still be welcome on the position of the EV user in the charging operation, although we would favour the 2014 EU directive on alternative fuels' logic.

In Madeira, the local Parliament has more power than on the other SMILE islands and EEM, the vertically integrated electricity operator of the island system (in virtue of a derogatory market liberalisation regime agreed by the Commission), is dealing with most of the sector. As a result, EEM owns and operates all electricity storage directly connected to the grid. Regarding EVs, the regime is similar to the one on mainland, with competition in the charging point operator activity, but the one electricity supplier appears to remain EEM.

5 Conclusion and recommendations

This deliverable presented EU market liberalisation rules and their exemptions. Some of these exemptions are specifically (but not only) applicable to islands, as the provisions for isolated systems, and some others can be used on islands or elsewhere, such as energy communities. However, this deliverable was more specifically dedicated to the analysis of the EU and national legal and regulatory challenges concerning the electricity storage technologies installed for the SMILE project: stationary storage by using electricity batteries or P2X, and indirect storage using EVs connected to the grid via a (smart) charging station. In the following paragraphs, the conclusions and recommendations arising from the SMILE project are presented organised by theme: stationary electricity storage, EVs (smart) charging, isolated systems and energy communities.

5.1 Conclusion and recommendations for electricity storage

The 2019 Electricity Directive provided a long-awaited legal framework for electricity storage, with a definition, rules for ownership and operation, and indications on ending the current situation that results in double-charging. The definition of energy storage is broad and therefore also applies to the possible conversion to other energy carriers than electricity, opening a window of opportunity for P2X technologies. The rules for ownership and operation make clear that electricity storage is a commercial activity as a result of which the involvement from network operators is limited, apart from some specific and limited situations. On double-charging, although the new directive provisions do not mention clearly any obligation to end it, they increase the pressure to terminate these barriers.

When considering developments at the Member States level, it appears that from all SMILE countries, the UK currently has the most developed regulatory framework for electricity storage. This set of rules is also widely consistent with the new EU provisions for electricity storage. Therefore, it can provide a model for other EU (or non-EU) countries, even though it is not perfect. The definition retained and the way to fight double-charging in the UK can nevertheless be criticised. The definition can be criticised for its lack of broadness as it does not integrate energy conversion and use as another energy carrier than electricity. Regarding the fight against double-charging, it still needs to be completed and it could be organised in another way, for example by imposing fees and taxes on the electricity taken from the grid instead of the electricity injected into the grid, or on taxing only the energy losses during the conversion process to foster the most efficient technologies.

- **Recommendation 1:** The implementation of the 2019 Electricity Directive measures on electricity storage in Member States' legislation has to be closely monitored by the European Commission. The adopted definitions must be broad enough to encompass energy conversion and allow P2X, thus diversifying the range of technologies that can be used. The measures adopted by Member States to control and suppress electricity storage double-charging are also of paramount importance. Guidelines should be adopted by the European Commission in order to implement an adapted framework for a fair treatment of storage assets and to foster their integration into the market.
- **Recommendation 2:** In ending double-charging, Member States have three potential options. Firstly, Member States can decide to impose taxes and fees only on the electricity injected by a storage equipment to the grid. This is the solution currently implemented in the UK. Secondly, Member States can impose taxes and fees only on the electricity taken from the grid by the storage asset. Thirdly, Member States can impose taxes and fees only on the difference between the electricity taken from the grid and the electricity injected into the grid by the

storage asset: the energy losses. From the analysis, the second or the third option seem best suited to incentivise the deployment of the most efficient storage technologies available and limit energy losses. In both cases, the lower the conversion losses, the higher the benefits for the storage operator. Out of these two options, the last one would most incentivise the deployment of storage and more importantly reduce energy losses, although it might be the costlier for the state and the TSO.

5.2 Conclusion and recommendations for EVs (smart) charging

The 2014 Directive on the deployment of alternative fuels infrastructure already provides the basic rules for the development of an EV charging infrastructure in the EU. The 2019 Electricity Directive added an important provision as it prohibits DSOs to own or operate a public charging station. This provision highlights that using EVs as a mobile electricity storage asset through the connection of a (smart) charging station is legally considered as a type of electricity storage, as similar rules apply for ownership and operation.

At the Member States level, Portugal is the SMILE country with the most developed legal regime for EVs and their charging stations, even though it can still be perfected. Its framework provides enhanced clarity on the role of the different actors in the public charging operation: the electricity supplier, the charging point operator, and the e-mobility network operator. Focusing on smart charging alone, it is the UK which has the most advanced setting, with private and public EV charging points increasingly required to be smartened. This can considerably support using EVs for demand-response services.

- **Recommendation 3:** Both Portugal and the UK provide a legal (and regulatory) framework for the development and operation of (smart) charging services for EVs. However, for them as for any other EU Member States, it is essential to follow the logic of the 2014 Directive on alternative fuels, especially of its article 4 (8) where it is explained that the charging station operator is the final customer, henceforth enjoying freedom of choice of a supplier. EV users are therefore buying a service including but not only composed of electricity and cannot directly choose their supplier. These rules have not been clearly understood and applied over the EU.

5.3 Conclusion and recommendations for isolated systems

Isolated systems may benefit under some specific circumstances from derogations to the market liberalisation rules. The most prominent example within the SMILE project is Madeira, which has been exempted from the unbundling provisions and EEM is able to remain in place as a vertically integrated company. The 2019 Electricity Directive partially amended the regime for isolated systems as a result of which the focus now will be more on the intensity of the use of the interconnection with mainland grid (if there is one) than on the total electricity consumption on the island. The topic of isolated systems may gain attention in the coming years, as more and more islands become increasingly autonomous as regards their electricity generation, although their link to the national grid often remains vital for balancing purpose.

- **Recommendation 4:** The BRIDGE Regulations Working Group 2019 report already provided recommendations on isolated systems partly based on the SMILE project. Indeed, the interpretation of the 5% of annual electricity consumption obtained through the interconnection is of great importance for the assessment of the situation of an island and for

granting it derogations to market liberalisation rules, or not. EU islands energy actors (producers, network operators, suppliers, municipalities, and maybe soon energy communities) should also have a thorough look at these provisions and reflect on the evolution of their own electricity mix within the energy transition towards renewable energy sources and a potentially increased autonomy. They might be able to unlock a facilitated market regime which could simplify some aspects of their transition.

5.4 Conclusion and recommendations for energy communities

Citizen and Renewable Energy Communities are two novelties introduced by the 2018 Renewable energy Directive and the 2019 Electricity Directive. These mechanisms can foster the development of a locally driven energy transition towards renewable energy sources with a greater involvement of local communities. Islands provide a naturally fertile ground for the use of energy communities as their population often already forms a tight-knit community as the cases of Samsø and the Orkneys accurately show.

- **Recommendation 5:** EU islands energy actors are strongly advised to analyse the opportunities offered by Energy Communities under EU law and to follow the transposition process in their national legal framework. An ambitious local implementation of these measures may accelerate islands' energy transition by involving their communities and fostering a just transition.

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- 239 See ERSE’s website, [http://www.erse.pt/pt/Paginas/search.aspx?k=armazenamento] accessed 22 March 2019.
- 240 An updated list of which can be found on ERSE’s website [http://www.erse.pt/pt/legislacao/diplomas/Paginas/MobilidadeEletrica.aspx?master=ErsePrint.master] accessed 25 March 2019.
- 241 This presentation of the actors of the e-mobility system comes from a cross-research of the different versions of the Decree-Law 39/2010 and of various works and opinions, among which are to be cited: SMILE project, deliverable 4.1, appendix D: Extended Summary of Legislation; Frederica Gonçalves dos Santos, “A rede de Mobilidade Elétrica em Portugal – as incidências do Direito Público e Europeu na criação de um novo paradigma de mobilidade”, Master thesis, Universidade Católica Portuguesa, 2017, pp. 17-27; Monica Carneiro Pacheco, Bernardo Cunha Ferreira, “CMS e-guides”, Portugal, *eguides.cmslegal.com*, 11 March 2019, [https://eguides.cmslegal.com/electric_vehicle#] accessed 25 March 2019; Catarina Brito Ferreira, Martim Vaz da Silva, “Charging electric vehicles – liberalisation and new opportunities”, *internationallawoffice.com*, 28 September 2015, [https://www.internationallawoffice.com/Newsletters/Energy-Natural-Resources/Portugal/Morais-Leito-Galvo-Teles-Soares-da-Silva-Associados/Charging-electric-vehicles-liberalisation-and-new-opportunities] accessed 25 March 2019.
- 242 *Id.*
- 243 See subsection 2.3.3 of this deliverable.
- 244 SMILE project, deliverable 4.1, pp. 36 – 40.
- 245 *Id.*, p. 14.
- 246 Regional Legislative Decree 5/2017/M.
- 247 As it is a task of the DGEG in Portugal according to art. 15 of the Decree-Law 90/2014.
- 248 Monica Carneiro Pacheco, Bernardo Cunha Ferreira, “CMS e-guides”, Portugal, pt 4, *eguides.cmslegal.com*, 11 March 2019, [https://eguides.cmslegal.com/electric_vehicle#] accessed 25 March 2019.
- 249 SMILE project, deliverable 4.1, pp. 12-13.

Annex 1 - Market Liberalisation on EU islands (other than SMILE countries)

There are close to 600 inhabited islands in the EU, going from a few inhabitants to more than 50 000 islanders.¹ Due to their size, population, distance from mainland, and the existence or not of an electric interconnection these islands follow different regimes when it comes to their electricity system. In the following pages, we will provide a snapshot of these regimes according to the country and the type of island (or groups of). The information gathered hereunder was collected directly from the concerned islands via a questionnaire elaborated by DAFNI and RUG and distributed by DAFNI to its network of EU islands, additionally to a desk study.

As a general rule, islands that are interconnected to the mainland electricity system follow the electricity market design of the mainland, whereas the picture is mixed for non-interconnected islands depending on how fast market liberalisation is progressing, whether electricity market unbundling is technically feasible and whether there are derogations in place and agreed with the European Commission. The table below provides an overview of the situation.

Table 1: Status of electricity markets in EU islands

Islands	Electricity market	Comments
Azores (PT)	Bundled	
Balearic islands (ES)	Unbundled	
Canary islands (ES)	Unbundled	
Croatian islands (CR)	Unbundled	
Cyprus (CY)	Partially unbundled	Generation and supply are liberalised in theory but not in practice, TSO and DSO are part of the integrated undertaking
Dutch Islands (NL)	Unbundled	
Faroe islands (FO)	Bundled	Generation is in theory open to competition but very limited
Finnish islands (FI)	Unbundled	
French islands (interconnected) (FR)	Unbundled	
French islands (Non-connected islands close to the shores)	Partially unbundled	Generation alone is open to competition
Corsica (FR)	Partially unbundled	Generation alone is open to competition
French islands (Outermost Regions) (FR)	Partially bundled	Generation alone is open to competition
Greek islands (interconnected)	Unbundled	
Greek islands (non- interconnected) (GR)	In unbundling process	Special cases in Crete and Rhodes
Ireland (IE)	Unbundled	
Italian islands (interconnected) (IT)	Unbundled	
Italian islands (non-interconnected) (IT)	Unbundled/ Bundled	Depending on who is the DSO (Enel or a local small DSO)
Malta (MT)	Bundled	Generation alone is open to competition
Swedish Islands (Gotland, Öland) (SE)	Unbundled	

¹ European Parliament, Islands of the EU: Taking account of their specific needs in EU policy, 2016 [http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573960/EPRS_BRI(2016)573960_EN.pdf].

Azores (PT)

Electricity generation in the Autonomous Region of the Azores is regulated because this region benefits from a derogation from the application of Directive 2003/54/EC for an indefinite period of time. This decision frees the island from applying the provisions of Chapters III, IV, V, VI, VII of the directive.² The archipelago of the Azores is considered a 'micro isolated system', where the principles of unbundling are to be applied. Therefore, Electricidade dos Açores (EDA) acts as the main producer, DSO and supplier in the archipelago.

Balearic islands (SP)

Before the electricity interconnection between the Spanish peninsula and the Balearic Islands entered into service, the Balearic Islands electricity system comprised two small-sized subsystems which were electrically isolated: Majorca-Menorca and Ibiza-Formentera. In 2016, the two electricity subsystems of the Balearic Islands were finally connected to each other and to mainland by the Majorca-Ibiza double electricity link.³ Generation and supply are open to competition, transmission is under the responsibility of Red Eléctrica de España (REE) and distribution under Endesa. Royal Decree 738/2015 is an important text which regulates the electricity production activity and the dispatch procedure in non-peninsular electricity systems.⁴

Canary islands (SP)

Similarly to the Balearic islands, generation and supply are liberalised, REE is the TSO and Endesa the DSO. Royal Decree 738/2015 also applies to these islands.

Croatian islands

Generation and supply are open to the market in Croatian islands, although the biggest part is covered by the Croatian state-owned energy utility HEP and its supply unit, HEP Elektra. The TSO for the whole country is HOPS, while the DSO for the whole country as well is HEP-DSO.⁵

Cyprus

Cyprus was under a special regime with Directives 2003/54/EC and 2009/72/EC and benefited from a derogation in view of applying a delayed timetable for full market opening. As a small and isolated system, Cyprus has opted not to apply the provisions regarding distribution network operation unbundling and under Article 44 of the Directive 2009/72/EC, Cyprus is exempted from the provisions of Article 9 of the Directive, regarding transmission system ownership and operation. Although the electricity market in Cyprus has already been liberalised, with the possibility of multiple generation and retail supply firms operating in a competitive market, the Electricity Authority of Cyprus (EAC)

² Commission decision 2004/920/EC of 20 December 2004: derogation from certain provisions of directive 2003/54/EC concerning the archipelago of the Azores.

³ REE, Electricity link Majorca-Ibiza - Safe and sustainable energy for the Balearic Islands, 2013 [https://www.ree.es/sites/default/files/01_ACTIVIDADES/Documentos/Romulo2_en.pdf].

⁴ Real Decreto 738/2015, de 31 de julio, por el que se regula la actividad de producción de energía eléctrica y el procedimiento de despacho en los sistemas eléctricos de los territorios no peninsulares. See also the following publication for a detailed analysis of the new regulation for isolated power systems in Spain: Manuel Uche-Soria, and Carlos Rodríguez-Monroy, 'Special Regulation of Isolated Power Systems: The Canary Islands, Spain', *Sustainability*, 10 2018 [<https://www.mdpi.com/2071-1050/10/7/2572>].

⁵ See Mateo Beus et al., 'Electricity Market Design in Croatia within the European Electricity Market—Recommendations for Further Development', *Energies*, 11 2018 [<https://www.mdpi.com/1996-1073/11/2/346>].

holds nearly 100% of retail supply and over 90% of generation. The TSO and DSO are still owned by the Electricity Authority, despite plans to make them independent, which have been pushed back to 2020.⁶

Dutch islands

The Dutch islands are all interconnected to the mainland and follow the electricity market structure of the Netherlands. It is a liberalised market, and the DSO in charge of islands is Liander.

Faroe islands

The electric utility SEV is owned by the Faroese municipalities, and its purpose is to produce, transmit, distribute and supply electricity to Faroese customers. SEV is a vertically integrated undertaking, hence active in all of the electricity chain from production to supply. In principle, pursuant to the Electricity Production Act, market competition in the production of electricity is possible. However, the situation at present is that SEV controls around 97% of the electricity production, while Sp/f Røkt accounts for around 3%. SEV holds the monopoly on the transmission, distribution and supply of electricity.⁷

Finnish islands

The majority of the inhabited Finnish islands are interconnected with the mainland. Finland's electricity market was gradually opened to competition after the passing of the Electricity Market Act in 1995. Since late 1998, all electricity users, including private households, have been able to choose their preferred electricity supplier. Fingrid is Finland's (unbundled) TSO and at the end of 2017, 48 out of the 77 DSOs were legally unbundled.⁸

French islands

Interconnected

Some French islands close to mainland's shores are interconnected to its system with undersea cables and apply the same regime.⁹ France liberalised its electricity sector progressively to comply with EU directives, eliminating EDF's monopoly. Its current system sees its TSO (RTE) and its main DSO (Enedis) unbundled. Smaller DSOs can be exempt from this requirement, according to EU law.¹⁰

Non-connected islands close to the shores

Some islands facing Brittany or Normandy (two French regions on the Atlantic) coasts are not interconnected to mainland's grid, i.e. Ouessant, Molène, Sein, Chaussey and Les Glénans. In these islands, production is open to competition, but EDF-SEI is the only DSO (no transmission system on these islands) and supplier.¹¹

⁶ Elias Hazou, "Deadline to liberalise energy market passes again", *cyprus-mail.com*, 18 September 2018 [<https://cyprus-mail.com/2018/09/18/deadline-to-liberalise-energy-market-passes-again/>] accessed 9 April 2019.

⁷ *Vinnumálaráðgjafi*, Ministry of Trade and Industry, Comprehensive Plan for Electric Energy in the Faroe Islands, 2011, p. 10 [file:///X:/My%20Downloads/Comprehensive+Plan+for+Electric+Energy+2011.pdf].

⁸ *Energiavirasto*, Energy Authority (NRA), National Report 2018 to the Agency for the Cooperation of Energy, 2018 [https://energiavirasto.fi/documents/10191/0/National+Report+2018+Finland+1411-480-2018_20180726.pdf/10b8e538-2eef-4e97-8629-aafd4ad9ee02].

⁹ EDF Iles du Ponant, undated, [<https://opendata-iles-ponant.edf.fr/pages/home/>] accessed 9 April 2019.

¹⁰ CRE, Electricity networks, 12 June 2018, [<https://www.cre.fr/en/Electricity/Electricity-networks/Electricity-networks>] accessed 9 April 2019.

¹¹ CRE – Smart grids, Les zones insulaires, Introduction, undated [<http://www.smartgrids-cre.fr/index.php?rubrique=dossiers&srub=zonesinsulaires&action=imprimer>].

Corsica

Electricity production is open to competition even though EDF owns the largest part of the total installed 859 MW (end 2016).¹² EDF also acts as the TSO and DSO in Corsica, through its subsidiary EDF SEI and is the only supplier.¹³

Outermost regions

Similarly to Corsica, in the islands of Guadeloupe, La Réunion, La Martinique, and Saint-Pierre et Miquelon, electricity production is open to competition, EDF owns the largest part of the installations, and EDF is also the TSO, DSO and only supplier.¹⁴ These islands being outermost regions, they benefit from the special regime of article 355 TFEU.

Greek islands

Interconnected

Until end of 2018, 26 islands in Greece had been interconnected to the mainland grid and are following the market structure of mainland Greece. The market is fully liberalised with the TSO being ADMIE S.A., the DSO DEDDIE S.A., and the market operator being LAGIE S.A.

Non-interconnected islands (NII)

Currently in these islands, distribution and supply is reserved to DEDDIE SA (The Hellenic Distribution Network Operator) and PPC (Public Power Corporation) respectively. Crete and Rhodes are exceptions as electricity supply is open to competition since June 2016 and January 2017. Generation is open to competition, also PPC is a prominent actor.

In 2014, RAE (the NRA) adopted the Operation Code for Non-Interconnected Islands (NII Code), which largely completed the secondary legislation regulating the operation and the transactions in the NII electrical systems, setting the grounds for fully open competitive markets, in both the production and the supply activities on these islands. At the same time, the European Commission, acknowledging unique conditions, granted to Greece a derogation from the provisions of Chapters III and VIII of Directive 2009/72/EC for the NIIs: a) for refurbishing, upgrading and/or expanding PPC's existing power plants until 01.01.2021, but not for new capacity, b) for a maximum of five years after the adoption of the NII Code, until the necessary infrastructure is in place, for the activity of supply.¹⁵ In 2016, the EC decision was transposed into Greek Law (4014/2016). The EC Decision and the new law also granted the right to "alternative electricity suppliers" to participate in NIIs. The market was opened in Crete and in Rhodes as written above and until today, 13 and 12 suppliers have been active in Crete and Rhodes respectively. Since January 2018, RAE decided to remove the entire NII systems from the derogation status. Therefore, the market is being progressively opened to new suppliers in all NIIs until mid-2020, since in many systems the infrastructure required for such operations, namely Energy Control Centers and Information Systems, is not yet in place.¹⁶

¹² EDF, Systèmes énergétiques insulaires – Corse - Bilan prévisionnel de l'équilibre offre / demande d'électricité, 2017, p. 9

[https://corse.edf.fr/sites/default/files/SEI/producteurs/corse/edf_sei_bp2017_corse.pdf].

¹³ To have a look at EDF SEI Corsica, see [<https://corse.edf.fr/edf-en-corse>].

¹⁴ CRE – Smart grids, Les zones insulaires, Introduction, undated [<http://www.smartgrids-cre.fr/index.php?rubrique=dossiers&srub=zonesinsulaires&action=imprimer>]. There are also other isolated systems, such as Nouvelle-Calédonie or Wallis & Futuna, with the same logic of vertically integrated undertaking.

¹⁵ Commission decision of 14 August 2014 granting the Hellenic Republic a derogation from certain provisions of Directive 2009/72/EC of the European Parliament and of the Council.

¹⁶ RAE, National Report 2017 - Regulation and performance of the electricity market and the natural gas market in Greece in 2016, 2017, pp. 97 – 101 [http://www.rae.gr/site/file/system/docs/ActionReports/national_2017].

Ireland

The Irish electricity market has been fully liberalised since the implementation of full retail competition on 19 February 2005. The all-island (i.e. Ireland and Northern Ireland) wholesale single electricity market (the “SEM”), introduced on 1 November 2007, radically reformed the Irish electricity sector. In the SEM, the market operator for the island of Ireland is a joint venture between the Irish TSO, EirGrid plc, and the Northern Irish TSO, SONI Limited. They are collectively known as the single electricity market operator (“SEMO”).¹⁷

In accordance with EU Directive 2009/72/EC (as implemented in Ireland by a number of statutory instruments), the structure of the Irish electricity market has in recent years undergone a significant shift as an Irish commercial semi-state owned company, the Electricity Supply Board (the “ESB”) previously involved in generation, transmission and distribution has been “unbundled”. The electricity transmission system is still owned by ESB (still owned by the state). Distribution of electricity in Ireland is overseen by the ESB. ESB is licensed by the CRU (Commission for Regulation of Utilities) as owner of the electricity distribution network, known as the “distribution asset owner” (the “DAO”), and an independent subsidiary company of the ESB, ESB Networks Designated Activity Company (“ESB Networks DAC”), is the licensed DSO. Generation and supply are fully open to competition.¹⁸

Italian islands

Interconnected

Interconnected islands of Sardinia, Sicily, Ischia, Capri, Procida, Elba, La Maddalena and Sant’Antioco follow the market structure of mainland Italy, which is fully unbundled. Since the 1990s, regulations in the Italian electricity market aimed at unbundling generation, transmission and retail companies, which led to the introduction of a free market for the sale of electricity to customers. Retail market liberalisation started in 1999 with the passing of the so called ‘Bersani Decree’ (1999). As of 2016, Enel dominated the Italian retail electricity market, with a market share of 35% and sold 94 TWh (+6.9%). Edison is the second largest supplier, with 5% of the market (12 TWh in 2016), followed by Eni (4%) and Gala (4%). These four companies account for nearly half of the retail market sales. In 2016, regulated electricity tariffs still concerned around 60% of the Italian population.¹⁹

The Italian transmission network is almost entirely owned and is fully operated by Terna, a state-owned company. The distribution market is also very concentrated, with Enel operating 86% of the network despite the existence of more than 133 mostly municipal local operators.²⁰

Non-interconnected

For islands where Enel is the DSO, the generation is open to competition. We have no information on the supply (open to competition or not).

For islands with small local DSOs, the market structure is bundled. DSOs are also energy producers and retailers (vertically integrated undertakings) and are subject to tariff integration schemes. Right now, there is an ongoing request for derogation from UE directives “2003/54/CE” and “2009/72/CE” about unbundling rules.

¹⁷ SEMO, About the Single Electricity Market, undated, [<https://www.sem-o.com/about/>] accessed 11 April 2019.

¹⁸ Garret Farrelly, Rachel Ahern and Owen Collins, Ireland, Law and Practice, *practiceguides.chambers.com*, 31 July 2018, [<https://practiceguides.chambers.com/practice-guides/alternative-energy-power-2019/ireland/1-general-structure-and-ownership-of-the-power-industry>] accessed 11 April 2019.

¹⁹ Unnamed, “Italy’s retail power and gas markets will be fully liberalized in 2019”, *enerdata.net*, 4 August 2017, [<https://www.enerdata.net/publications/daily-energy-news/italys-retail-power-and-gas-markets-will-be-fully-liberalized-2019.html>] accessed 11 April 2019.

²⁰ Terna, Introducing Terna, undated, [<https://www.terna.it/en-gb/chi-siamo/ternainbreve.aspx>] accessed 11 April 2019.

Malta

Directives 2005/89/EC and 2009/72/EC were transposed into national law through the Electricity Market Regulations (S.L.545.13). These regulations take into account the derogations granted to Malta by virtue of Article 44 of Directive 2009/72/EC from the requirements of Article 9 (Unbundling of TSOs) and Article 26 of Directive 2009/72/EC (Unbundling of DSOs). Therefore, these two articles do not apply to Malta.

There is actually no transmission system in Malta. The electricity distribution system covering the whole country remains under the responsibility of a single DSO which forms part of a vertically integrated undertaking, Enemalta plc. Unbundling is required for internal accounts management level only. Enemalta plc remains the only undertaking in Malta holding a license to supply electricity to final customers. However, generation is open to competition.²¹

Swedish Islands

Close to 100% of the Swedish islands are interconnected to the mainland via cables. Production and supply in Sweden are liberalised, but are dominated by a small number of major stakeholders. Vattenfall represents slightly over 40 per cent of total production, and together with Fortum and Uniper the three biggest stakeholders are responsible for approximately 73 per cent of the production. At the end of the year, the three biggest electricity suppliers had a total market share of 41 per cent in terms of number of customers. This figure remained at approximately the same level over the past four years although there were 123 electricity suppliers on the Swedish electricity market at the end of 2017. Svenska Kraftnät is the TSO, whereas ownership and operation of the regional distribution systems is concentrated in three large business groups, Vattenfall, E.ON and Fortum. Several of the local distribution networks are owned and operated by local municipalities.²²

²¹ Regulator for Energy & Water Services, Malta's Report to the European Commission on the Implementation of Directive 2009/72/EC, Directive 2009/73/EC and Directive 2005/89/EC, 2017, pp. 4 – 6 [file:///X:/My%20Downloads/85a3d917-72ac-4db3-8031-617293354887_31d4ce6f-d154-451b-a636-a57b68c57c4d.pdf].

²² See Swedish Energy Markets Inspectorate, *Energimarknadsinspektionen*, The Swedish electricity and natural gas market 2017, 2018 [https://www.ei.se/PageFiles/313846/Ei_R2018_11.pdf].

Annex 2 - Electricity storage developments in EU islands (other than SMILE countries)

Hereunder are some storage projects taking shape in EU islands, highlighting the variety of initiatives on these territories.

El Hierro, Canary Islands, Spain

The wind-hydro hybrid plant of El Hierro consists in a wind farm connected to a pumped hydroelectric storage plant. The wind farm can supply electrical energy directly to the grid and simultaneously store surplus energy by feeding the pumping station, which pumps water to an upper reservoir as an energy storage system. The hydroelectric plant can then take advantage of the stored potential energy, ensuring electricity supply and grid stability. The final cost of the wind-hydro project was estimated at 82 million euros.

The wind-hydro system is comprised of the following elements:

- Upper reservoir: situated in the “La Caldera” crater, with a maximum capacity of 350 000 m³, with an invert elevation of 698 m.
- Lower basin: situated close to the Llanos Blancos plant, with a working storage capacity of 150 000 m³, with an invert elevation of 43 m and a water depth of 56 m.
- Two above-ground pipes: one, 3015 m long and 0.8 m in diameter, connected to the pumps, and the other 2350 m long and 1 m in diameter, connected to the turbines.
- Pumping station: 2 groups of 1500 kW each and 6 groups of 500 kW each, with a total power of 6 MW.
- Turbine plant: 4 2830 kW Pelton turbines, with a total power of 11.32 MW. Maximum flow rate is 2.0 m³/s, with a gross head of 655 m.
- Wind farm: comprised of 5 Enercon E-70 wind turbines, each with a rated power of 2.3 MW making a total rated power of 11.5 MW.

The control system has been designed so that only wind energy can be stored. The estimated mean annual data concerning the facility are as follows:

- Wind Farm: Estimated annual energy production of 40.36 GWh.
- Hydro Pumping Stations: Estimated annual energy consumption of 29.21 GWh.
- Hydroelectric Plant: Estimated annual energy production of 19.34 GWh.

A total of 72.4% of the wind energy generated will be used for the storage system. The expected yield for the storage system is 66.2%. The annual operating result estimation for the island of El Hierro is distributed in 73.4% of renewable energy and the rest, 26.6%, will be generated by existing diesel generators.¹

The project is promoted by Gorona del Viento (GdV) El Hierro, S.A., with participation by the Council of El Hierro (66 %), Endesa (23 %), Government of the Canary Islands (3 %) and ITC (8 %).²

Gorona del Viento, the company that manages the project, was expected to receive 7 million euros for 2015 alone. These payments seem to be based almost entirely on a clause that guarantees Gorona

¹ See Francisco Javier García Latorre, Jose Juan Quintana and Ignacio de la Nuez, ‘Technical and economic evaluation of the integration of a wind-hydro system in El Hierro island’, *Renewable Energy*, 134 2019, pp. 186 – 193.

² See Jaime Palomares Nuno Taveira, Eckard Quitmann and Juan Gil Alberto Castaneda, ‘The Hybrid Power Plant in El Hierro Island: Facts and Challenges from the Wind Farm Perspective’, 3rd International Hybrid Power Systems Workshop, 2018 [http://integrationworkshops.org/crete/wp-content/uploads/sites/13/2018/05/1_3_TENE18_046_paper_Taveira_Nuno.pdf].

del Viento a return on investment. Payments for energy actually delivered are negligible in comparison. Dividing this amount of reimbursement for 2015 by the 35662 kWh of renewable energy generated by GdV in 2015 gives an average cost of 0.81 €/kWh. Electricity rates in Spain are the same everywhere so these costs will be borne by the Spanish taxpayer and not by the residents of El Hierro.³

Corsica, France

Akuo Energy, a French independent renewable energy producer, has developed 2 hybrid systems incorporating electricity storage to solar generation, fully funded by the same pool of senior lenders: CEPAC (Caisse d'Épargne Provence-Alpes-Corse) and Natixis Energéco, co-arrangers of the debt financing, along with backing from the Agence Française de Développement.

In particular:

- Olmo I: the first industrial solar power plant with combined storage in Corsica when it came into operation in the summer of 2014. With installed capacity of 4 MWp and lithium ion battery storage capacity of 4 MWh, the plant located in Aghione is responsible for reducing CO₂ emissions by 2556 tn/y, with an annual electricity supply equivalent to 1806 households.
- Mortella: The project located in Ghisonaccia is a 7MWp solar farm combined with a 7MWh electricity storage unit using lithium ion batteries. Producing electricity since August 2015, it is the island's biggest solar plus storage facility. The plant is responsible for reducing CO₂ emissions by 5352 tn/y, with an annual electricity supply equivalent to 3792 households. The agricultural and ecological use of the land around is focused on the planting of around one hundred olive trees for the production of organic olive oil.⁴

Another 67 solar-plus-storage projects in French Island Territories, among which 20 will be deployed in Corsica, were awarded in August 2017 to a number of different developers. The latest competitive tenders to develop PV and solar-plus-storage projects on island territories, held by the French government's energy regulator, CRE, brought winning bid prices down by as much as 40% compared to the winners of previous reverse auctions. The 67 projects attained a guaranteed purchase price for their generated power of €113.6 per MWh. This is highly competitive with power prices on these islands, mainly coming from diesel gen-sets and estimated at around or over €200 per MWh.⁵

Faroe Islands

The power company SEV, which is an inter-municipal community owned by all the municipalities in the Faroe Islands, has commissioned Europe's first fully commercial Li-ion energy storage system operating in combination with a wind farm. Saft's containerised solution is helping to maintain grid stability so that the islanders can capture the full potential of their ENERCON 12 MW Húshagi wind farm, on the island Streymoy. Since coming on line in 2014, the wind farm has increased the islands' wind share to 26% of total electricity production.

To overcome short-term variations linked to the variable nature of wind, lasting from seconds to minutes, the 2.3 MW Li-ion battery has been deployed. It provides ramp control to smooth out sharp increases and decreases in power, as well as frequency response and voltage control services. The use of energy storage also helps to minimise the risk of curtailment during periods of high wind and low consumption. Excess wind energy that cannot be injected into the grid is now be stored in the

³ See Roger Andrews, "El Hierro Renewable Energy Project – End 2015 Performance Review and Summary", *euanmearns.com*, 4 January 2016 [<http://euanmearns.com/el-hierro-renewable-energy-project-end-2015-performance-review-and-summary/>] accessed 11 April 2019.

⁴ Akuo Energy, Akuo Corsica Energies, undated [<http://www.akuoenergy.com/en/akuo-corsica-energies>] accessed 11 April 2019.

⁵ Andy Colthorpe, "French island tenders push down solar-plus-storage prices by 40%", *energy-storage.news*, 14 August 2017 [<https://www.energy-storage.news/news/french-island-tenders-push-down-solar-plus-storage-prices-by-40>] accessed 11 April 2019.

batteries. With this system in place, wind curtailment decreased from 22% prior to the inauguration in 2015, down to 1.8% in 2018.⁶

Ikaria, Greece

The Ikaria Hybrid Power Plant is currently under construction by Public Power Corporation Renewables and is the first of its kind in Europe. The project consists of the Stravokountoura wind farm and the Proespera and Kato Proespera small hydroelectric power plants.

In particular, the project comprises three water reservoirs with a sufficient altitude difference:

- An existing reservoir at Pezi with a storage capacity of 900 000 m³ currently used for irrigation and water supply. Excess water from this reservoir will be exploited for energy generation.
- Two new reservoirs at Proespera and Kato Proespera with approximately a storage capacity of 80 000 m³ each, which will be exploited for pumped storage. The two pumped storage reservoirs are hydraulically connected using double pipeline to make energy generation and storage independent from each other.

The Hybrid Power Plant includes:

- Two small hydroelectric plants (SHP), both equipped with Pelton turbines, one at Proespera, with a rated power of 1.05 MW, to exploit excess water from Pezi dam and another at Kato Proespera, with a rated power of 3.1 MW, which exploits excess water from Proespera while participating in pumped storage operation.
- A pumping station, located at Kato Proespera, comprising constant and variable speed pumps rated at 3 MW.
- A 2.7 MW wind farm at Stravokoundoura.

In full operation, the hybrid project will help avoid CO₂ emissions of 13800 tn/y.⁷

Tilos, Greece

The TILOS Project was approved and funded by the European Programme HORIZON 2020.

The Hybrid Power System's components implemented in Tilos are comprised of:

- A medium-sized wind turbine of nominal capacity of 800 kW,
- 592 photovoltaic panels with a total capacity of 160 kWp,
- 8 Inverters of output capacity of 20kW,
- A NaNiCl₂ battery energy storage system of 800 kW/2.88 MWh.

It is estimated that during the year, the project covers 80-85% of the island's needs, and there are days and hours where Tilos's total demand is covered by renewable energy sources. Excess energy is then channeled to Kos via the existing underwater interconnection.

In addition to the energy production and storage system, the project includes modern systems for forecasting and controlling wind and photovoltaic production, as well as active demand monitoring and control systems by installing smart energy meters to a large number of local households and businesses.⁸

Sicily – Sardinia, Italy

Terna, the Italian TSO, has undertaken a wide experimentation and employment of large-scale stationary electrochemical energy storage. In one of its projects, the energy storage systems have the important role of supporting the electrical network during the frequency regulation processes. This operation mode requires power intensive performances involving short charge/discharge intervals.

⁶ Saft, 'Saft Li-ion energy storage enables SEV to optimize wind power for the Faroe Islands', 2016 [file:///X:/My%20Downloads/21972-1116-2_CS_IM+SEV+Faroe+Islands_P.pdf].

⁷ Stefanos V. Papaefthymiou *et al.*, 'A Wind-Hydro-Pumped Storage Station Leading to High RES Penetration in the Autonomous Island System of Ikaria', *IEEE Transactions on Sustainable Energy*, 1 2010.

⁸ See the webpage of the Tilos project [<https://www.tiloshorizon.eu/>].



The tested technologies are different types of Lithium-based, Sodium-Nickel chloride, and Vanadium Redox Flow batteries.

The installation sites are:

- Sardinia with a total capacity of 7.8 MW/11.93 MWh in Codrongianos,
- Sicily with a total capacity of 5.55 MW/9.3 MWh in Ciminna.

As a result of their high flexibility allowed by the power conversion system (PCS), the power intensive installations are used for grid ancillary services, such as primary and secondary frequency regulation, voltage regulation, and more. The operation, response and aging of these batteries is tested and the results are considered by the TSO.⁹

⁹ Roberto Benato *et al.*, “Italian Experience on Electrical Storage Ageing for Primary Frequency Regulation”, *Energies*, 11 2018.

Annex 3 - Other EU islands national regime

Hereunder, electricity storage legal frameworks in place in islands from some EU member states which have not been studied by the SMILE project are presented. The information appearing below was gathered directly from a range of EU islands based on a questionnaire redacted by DAFNI and RUG and distributed by DAFNI to its network of EU islands.

Balearic and Canary Islands / Spain

Electricity storage is not separately regulated in the Spanish legislative framework. Even though there is a specific regulation for electricity commercialisation for the islands, this regulation does not include any special indication for energy storage.

Nevertheless, a project of Climate Change and Energy Transition Regional Law considers the engagement of these kind of facilities. It is expected that the law will be definitively approved during the first quarter of 2019. Article 43 of the draft law establishes that the production of electric energy through renewable energy sources can be complemented by the installation of energy storage systems. Additionally, the draft law creates a Regional Energy Agency named Institut Balear de l'Energia that will be in charge of promoting the installation of energy storage systems in order to provide management capacity.

Since last October, when the approval of the RDL 15/2018 took place eliminating the tax on accumulation, thus opening the way to storage, the main barrier for energy storage was removed.

At the moment it is not determined whether energy storage will be utilized specifically for generation, load control, or peak management. Moreover, it is not currently defined who can own electricity storage as a grid asset.

The regulations applicable to energy storage projects do not differ from the general framework. Storage facilities are part of a power plant -usually a renewable energy plant-, therefore the relevant authorisations required for storage are included within the authorisation process for power plants. As a result, energy storage projects linked, for example, to hydroelectric power plants must hold an authorisation or license for the exercise of their activity. Holding a generation license places a number of obligations on the licensee, such as compliance with safety regulation, issuance of information to the public authorities, payment of the electricity system fees or the curtailment of the energy generated.

Croatian islands / Croatia

Electricity storage is not specifically regulated or supported by Croatian law.

For the moment, it is not determined whether energy storage will be utilised in any specific operation scheme. Moreover, it is not currently defined who can own electricity storage as a grid asset. Any private investor can own electricity storage if they get the Energy Permit from HERA, the Regulatory Authority for Electricity. In addition, it is required that the investor first gets preliminary connection approval and contract from Croatian DSO, HEP.

The main barriers for implementing electricity storage are technical, financial and regulatory. There is a lack of financial incentives that would make implementation of electricity storage technologies economically viable.

Cyprus

There is no legal framework for electricity storage in Cyprus. It is only specified that the TSO and the DSO shall take appropriate measures to develop the transmission and distribution system infrastructure, smart grids, storage facilities and the power system to allow for its safe and reliable operation in order to foster further development of electricity production from renewable sources. Currently, there is no specific operational scheme intended for storage, besides the long-term goal of storage as in many islands to balance the supply of electricity in energy systems with high RES penetration. Additionally, it is not currently defined who can own electricity storage as a grid asset.

Dutch islands / The Netherlands

The Netherlands have no specific legislation for energy storage. A bill combining and improving the current Electricity and Gas Act was drafted and rejected in 2015. The bill provided room for research and development for, amongst other projects, energy storage. Currently, the Ministry of Economic Affairs is redrafting the bill to facilitate experimental storage projects.

For the moment, it is not determined whether energy storage will be utilised in any specific operation scheme. Moreover, it is not defined who can own electricity storage as a grid asset. The energy market in the Netherlands is regulated by the Dutch energy regulator, the Authority for Consumers and Markets (ACM). The electricity distribution networks are publicly managed and owned. The Netherlands has one TSO, TenneT, which is owned by the state, and has the task of balancing supply and demand for electricity, in which energy storage could become a key factor in the future.

A primary conclusion is that energy storage in the Netherlands is still developing and, except for a 10 MW interconnected battery storage project, most projects are still in the exploratory phase. Furthermore, national legislation provides little to no incentives for the development of energy storage. Occasional incentives have been provided by local governments, which have signed “green deals” to support research into opportunities for energy storage.

Faroe Islands

There is no regulatory framework regarding electricity storage in the Faroe islands, and with the current setup, there is no obvious interest for other actors than SEV, the Faroese Power Company, which is operated as a natural monopoly owned by all the municipalities, to invest in storage, as there is no remuneration for ancillary services.

As it is, the current storage components are owned by SEV. Batteries are used for short-term storage, smoothening the variability of the wind power and, additionally, participating in the frequency control. Pumped hydroelectric storage, on the other hand, is considered for storing excess renewable energy and to produce energy when lacking wind and hydro.

Finnish islands / Finland

Current Finnish network regulation does not support DSOs procuring storage capacity from the market or possible storage ownership, but rather steers DSOs towards making traditional network investments.

Additionally, under the Finnish taxation regime and depending on the location of the storage system, electricity tax might be paid multiple times (double charging), since electricity storage is considered both as a consumer and as a producer of electricity. Therefore, there is a need to improve the taxation on grid-connected storage systems and to specify what is the role of storage in the grid, so that storage can be economically deployed.

French islands / Corsica

The Energy Transition Law (ETL) has set ambitious 2030 targets for renewable energy in France, and energy storage is mentioned as a necessary means to achieve environmental policy objectives.

Storage systems are defined in the Ministerial Order of 7 July 2016 as a set of stationary electricity storage equipment allowing the storage of electric power in one form and its reconversion, while being connected to the public power grids. The technologies can be pumped storage, hydrogen, electro-chemical batteries, etc. Storage can be connected to the public power grid directly or indirectly.

The current regulatory framework allows for energy storage, but there is no legal framework designed for its development. The French energy code refers to energy storage only three times: firstly, article L142-9-I creates a “National register of electricity production and storage systems”; secondly, article L315-1 provides that an individual plant for self-consumption may include the storage of electricity; and finally, article L121-7 specifies that in non-interconnected areas, the costs of storage systems managed by the grid operator are offset through the public service contribution of electricity.

Developing energy storage projects is quite challenging in some cases. For example, a stand-alone storage system (not co-located with generation) is considered by the transmission and distribution system operators as a consumer when it draws electricity from the power grid, and as a producer when it injects electricity into the power grid resulting in a double charge for accessing the grid. Separately, the feed-in tariffs regime for electricity production favors direct injection of electricity into the grid, rather than it being stored. Both factors have hindered the emergence of an energy storage market in France despite energy storage being a key driver of the clean energy transition and for the achievement of the ambitious targets set in the ETL.

Greek islands / Greece

In Greek legislation, there is no framework for electricity storage *per se*. Electricity storage projects covered by the legislation only concern hybrid plants combining RES with any form of electricity storage, as well as installing batteries as a secondary use in virtual net-metering applications.

Law 3468/2006 specifies that a hybrid plant is any power station that utilises at least one form of RES, its total energy absorbed by the grid on a yearly basis does not exceed 30% of the total energy consumed to fill the storage system and the maximum power output of its RES unit does not exceed the installed capacity of the storage unit plus 20%. There is no further limit on the storage capacity of a storage medium for a hybrid station, irrespective of its type. Indicative of this is that applications for battery-based hybrid stations, as deposited, in many cases foresee a guaranteed power of more than 1 MW. The licensing procedure for hybrid stations is similar to the one that applies to each RES technology deployed in the hybrid station. While applications for hybrid stations now include both pumped hydroelectric storage and batteries as storage part, it must be underlined that all the recommendations from the Regulatory Authority for Energy in Greece for improving the regulatory framework for storage refer only to hybrid stations with pumped hydroelectric storage.

In March 2019, a Ministerial Decree modified Law 3468/2006 and allowed producers of electricity under a net-metering scheme to install energy storage systems for self-consumption optimisation. Nominal power capacity of such storage systems is set at a maximum of 30 kVA, and these storage systems are not allowed to exchange power with the grid but are only used to increase self-consumed energy and hence reduce the amount of regulated charges required to be paid by the consumer.

Currently it is not determined whether energy storage will be used in any specific operation scheme, besides the long-term goal of storage in many islands, which will be to balance the supply of electricity in energy systems with high RES penetration. Moreover, it is not currently defined who can own electricity storage as a grid asset.

Ireland

The Irish electricity regulatory framework does not currently recognise electricity storage as a licensable activity in its own right. Therefore, the business of any entity engaged in electricity storage is regulated on the basis of separate licensable activities, in particular the supply and generation of electricity. Currently, it is not defined who can own electricity storage as a grid asset.

Specific treatment of batteries and pumped storage units was, however, introduced into the wholesale electricity market rules as part of I-SEM go-live. The integrated single electricity market ("I-SEM") sees the introduction of new day-ahead and intraday markets, along with significant changes to balancing arrangements.

Italian islands / Italy

Depending on its final application, energy storage can be a production, transmission or distribution asset. Having said that, a specific and complete regulation is missing in Italy but is currently under development especially to allow energy storage facilities to provide grid services. Terna, the Italian TSO, has recently launched several Pilot Projects with the aim to include new technologies, including electricity storage, as possible providers for grid ancillary services. The following scheme is a brief overview of the current situation in Italy with regards to the possible application for energy storages on mainland and on non-interconnected islands:

- On mainland: UVAM (Mixed Virtual Aggregated Units). The Italian grid code only allows conventional thermal or hydroelectric plants (over 10 MW) to provide grid ancillary services. UVAM Pilot Project allows other flexibility resources (i.e. Demand Side Response, electricity storage, generation plants under 10 MW, RES, etc.), in the form of aggregates, with a minimum power of 1 MW overall, to provide grid ancillary services. The participation of these new resources is limited to 1 GW and supported by national subsidies. This Pilot Project has a duration of 2 years, until September 2020. Amendments and improvements are defined in the Regulation Authority's document "300/2017/R/EEL".
- On non-connected Islands: Ministerial Decree 14/02/2017 defines the RES target for 2020 for 20 Italian islands at 10% of RES penetration, the subsidies for RES energy production, subsidies for two special pilot projects (up to 10 million €) with the aim of enabling high RES penetration on these islands from 20% up to 50% by using innovative enabling technologies (i.e. electricity storage, water system integration, etc.). The Ministerial Decree 14/02/2017 is in force since 18/05/2017. The definition of the evaluation criteria for the special Pilot Projects is currently ongoing by Ministry of Economic Development.

Moreover, electricity storage is considered to be technologically neutral, so it is not limited to any specific technology, and its implementation will concern every sector, from residential to industrial and from commercial to utility.

Additionally, electricity storage is considered as a grid asset, when owned by TSO/DSO and a generation asset, when not owned by TSO/DSO. As a result, only the TSO and DSOs can currently own electricity storage as a grid asset.

The main constraints for electricity storage development are economical. Right now, the LCOS is still too high in most of the applications to consider electricity storage as a viable solution. Even with the UVAM regulation, payments for services are probably not enough to build an attractive business model especially for industrial clients. Incentive schemes like the one defined by the Ministerial Decree 14/02/2017 could surely help energy storage systems to be used as grid assets. However, a widespread deployment is still too distant when considering both residential and industrial clients. Specific incentives should be implemented for such type of application.

Malta

There is no regulatory provision regarding electricity storage in Malta.

Swedish islands / Sweden

There is no specific regulation or operational regime for electricity storage in Sweden. According to Swedish energy law, TSOs and DSOs are not allowed to produce or trade electricity. There are two exceptions to this rule: in case of grid losses or power failures. The current legal framework allows only private investors for energy storage. However, TSOs and DSOs can invest in energy storage systems and lease the storage capacity on a commercial basis to other players in the market.